Allen-Bradley

Capacitor Bank Controller

1413-CAP

User Manual

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://literature.rockwellautomation.com) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
SHOCK HAZARD	Labels may be located on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be located on or inside the equipment, for example, a drive or motor, to alert people that surfaces may be dangerous temperatures.

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Table of Contents

Preface

Who Should Use This Manual 3
Additional Resources 3

Chapter 1

General Information

Introduction 5
Description of the Capacitor Bank Controller 5
Functions 5
Options 6

Chapter 2

Installation

System Components 7
Optional Additional Powermonitor Meters 8
System Architecture 9
Base System with Serial Options 9
Base System with Ethernet Options 10
Assemble, Mount, and Connect Your Controller 11
MicroLogix 1500 Controller (All Configurations) 11
AIC + Interface Converter (All Configurations) 14
Powermonitor Meter (All Configurations) 14
PanelView 550 Serial Terminal (Serial HMI options) 16
PanelView 550 Ethernet Terminal (Ethernet HMI Option) 18
Configuration 20
Communications Configuration 20
Base Unit 20
Serial HMI Option 21
Ethernet HMI Option 21
Additional Powermonitor Meters Option 22
Powermonitor Meter Configuration 23
Parameter Descriptions 24
Set Parameters with the Powermonitor Display Module . . 24
Controller Configuration 26
Use the DAT for Configuration 31
Configuration with the PanelView 550 Terminal (Optional HMI Only) 33

Chapter 3

Operation

Introduction 37
Operating Modes 37
CTPT Modes 38
Alarms 39
Operator Interface 39
Data Access Terminal (DAT) 40
Optional PanelView 550 HMI 42

SCADA Interface

Chapter 4

Power-circuit Parameters 49

Add Special Functionality

Chapter 5

PFMGR4 Logic 51
- Overview 51
- Power Factor Alarm 52
- Step Control 52
- Step Routine 54
- User Variables 55

Catalog Number Explanation

Appendix A

Base Unit 61
- With Serial Powermonitor 1413-CAP-MS A 61
- With Ethernet Powermonitor 1413-CAP-ME A 62

Additional HMI 62
- Serial Base Unit with Serial HMI 1413-CAP-MS-PS A 62
- Serial Base Unit with Ethernet HMI 1413-CAP-MS-PE A . . 62
- Ethernet Base Unit with Ethernet HMI 1413-CAP-ME-PE A 62

Glossary

Index

Read this to familiarize yourself with the rest of the manual. It provides information concerning:

- who should use this manual.
- where to go for more information.

Who Should Use This Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting the Capacitor Bank Controller system.

You should have a basic understanding of electrical circuitry and familiarity with relay logic. If you do not, obtain the proper training before using this product.

Additional Resources

Please refer to the following publications for additional information on how to assemble, install, connect, operate and maintain your capacitor bank controller.

Additional Resources

For This Information	Refer to Publication
MicroLogix 1500 Technical Data	1764-TD001
MicroLogix 1500 User Manual	1764-UM001
Powermonitor 3000 Installation Manual	1404-IN007
Powermonitor 3000 User Manual	1404-UM001
Powermonitor 3000 Display Module Installation Manual	1404-IN005
PanelView 550 Installation Guide	2711-IN009
PanelView Standard Operator Terminals User Manual	2711-UM014

General Information

Introduction

The capacitor bank controller is a replacement for standard, fixed-function capacitor controllers currently on the market. The controller consists of standard, off-the-shelf, Allen-Bradley hardware with the application ladder code necessary to perform power factor correction. The controller is designed to provide the same base functionality as a fixed-function capacitor bank controller. Also, you may add additional code to the controller to fit its functionality to special circumstances.

Description of the Capacitor Bank Controller

The capacitor bank controller is a pre-engineered control system containing a MicroLogix 1500 controller, a standard data access terminal (DAT), one or more Powermonitor 3000 modules, and an optional additional human-machine interface (HMI). Pre-engineered ladder logic code in the controller gathers real and reactive power data from up to four power feeds (utility feeds and/or generators). The logic operates on the data in standard engineering units of kVAR and kW and acts to minimize imported and exported reactive power by switching up to 10 steps of capacitance. This strategy controls power factor while reducing the likelihood of voltage surge caused by excessive kVAR export.

Functions

- Auto configure
- Manual configure
- Discharge timer on each step
- Selectable operating modes
  - Manual operation
  - Linear, last-in, first-out
  - Balanced, level-out usage of capacitor steps
  - Optimal, finds best match of capacitor step to system kVAR needs
  - Special, customer-defined
  - %THD, Linear mode with a voltage %THD setpoint

- Alarms
  - Bad step, indicates blown fuse, capacitor failure
  - Target power factor not achieved
  - High / Low voltage
  - %THD High
  - Current unbalance
  - Metering
- Powermonitor data concentrated into the MicroLogix 1500 controller
- Phase current, line voltage, frequency, real and reactive power, power factor and THD

Options

- Up to three additional Powermonitor meters to aggregate up to four total feeds
- PanelView 550 keypad HMI terminal with serial or Ethernet communications
- Ethernet Powermonitor meters to produce power and energy data via your local area network

Installation

The capacitor bank controller system is supplied as a number of components that you assemble, install, and connect in a suitable enclosure.

System Components

The key number in the component lists are referenced in the illustrations that follow.

All Configurations

Key	Quantity	Part Number	Description
1	1	1764-24BWA	MicroLogix 1500 base unit with: 120/240V ac control power, (12) 24V dc inputs, and (12) relay outputs
2	1	1764-LRP	MicroLogix 1500 enhanced processor
3	1	1764-DAT	MicroLogix 1500 data access tool
4	1	1761-NET-AIC	Advanced interface converter (used for PM comms)
5	1	1761-CBL-AC00	MicroLogix controller to AIC+ cable, 9-pin D-shell to 9-pin D-shell, 45 cm (17.1 in.) long
6	1	1404-DM	Powermonitor 3000 display unit with 3 m (9.84 ft) cable

Base Unit with Serial Meter 1413-CAP-MSA

Key	Quantity	Part Number	Description
7	1	1413-M5000 A	Powermonitor 3000-M5 meter with RS-485 communications port including programmed MicroLogix 1500 8 k memory module with real-time clock (1764-MM1RTC)

Base Unit with Ethernet Meter 1413-CAP-MEA

Key	Quantity	Part Number	Description
7	1	1413-M5ENT A	Powermonitor 3000-M5 meter with Ethernet communications port including programmed MicroLogix 1500 8 k memory module with real-time clock (1764-MM1RTC)

Optional Serial HMI, Serial Meter 1413-CAP-MS-PSA

Key	Quantity	Part Number	Description
7	1	1413-M5000NM A	Powermonitor 3000-M5 meter with RS-485 communications port including programmed memory module with real-time clock (1764-MM1RTC) and programmed 2 MB flash memory card (2711-NM13)
8	1	2711-NC21	PanelView terminal to MicroLogix communication cable
9	1	2711-K5A16	PanelView 550 operator terminal with RS-232 DF1 serial communications

Optional Serial HMI, Ethernet Meter 1413-CAP-ME-PSA

Key	Quantity	Part Number	Description
7	1	1413-M5ENTNM A	Powermonitor 3000-M5 meter with RS-485 and Ethernet communications ports including programmed memory module with real-time clock (1764-MM1RTC) and programmed 2 MB flash memory card (2711-NM13)
8	1	2711-NC21	PanelView terminal to MicroLogix controller communication cable
9	1	2711-K5A16	PanelView 550 operator terminal with RS-232 DF1 serial communications

Optional Ethernet HMI 1413-CAP-ME-PEA

Key	Quantity	Part Number	Description
7	1	1413-M5ENTNM A	Powermonitor 3000-M5 meter with RS-485 and Ethernet communications ports including programmed memory module with real-time clock (1764-MM1RTC) and programmed 2 MB flash memory card (2711-NM13)
10	1	1761-NET-ENIW	MicroLogix Ethernet interface module with Web interface
11	1	1761-CBL-AM00	MicroLogix controller to AIC+ cable, 8-pin DIN to 8-Pin DIN, 45 cm (17.1 in.) long
12	1		3.05 m (10 ft) CAT5 Ethernet crossover cable
13	1	2711-K5A20	PanelView 550 operator terminal with Ethernet/IP communications

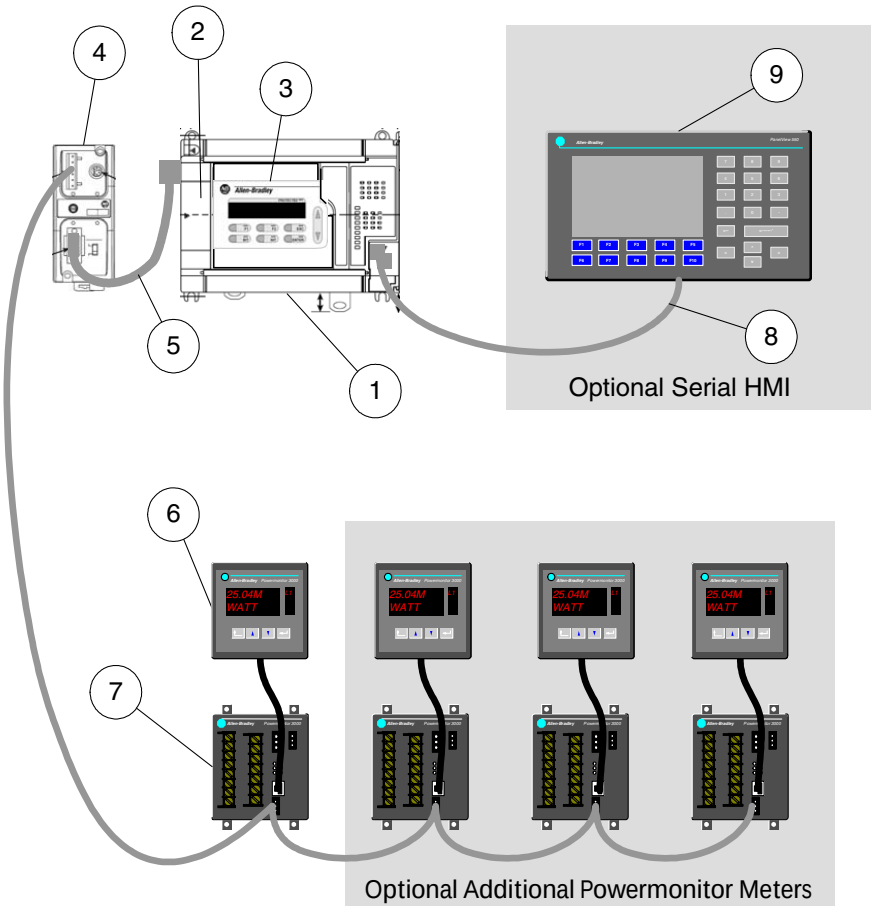
Optional Additional Powermonitor Meters

The controller is designed to operate with up to three additional Powermonitor meters. Additional Powermonitor meters must be ordered separately. Please contact your local Allen-Bradley distributor for information.

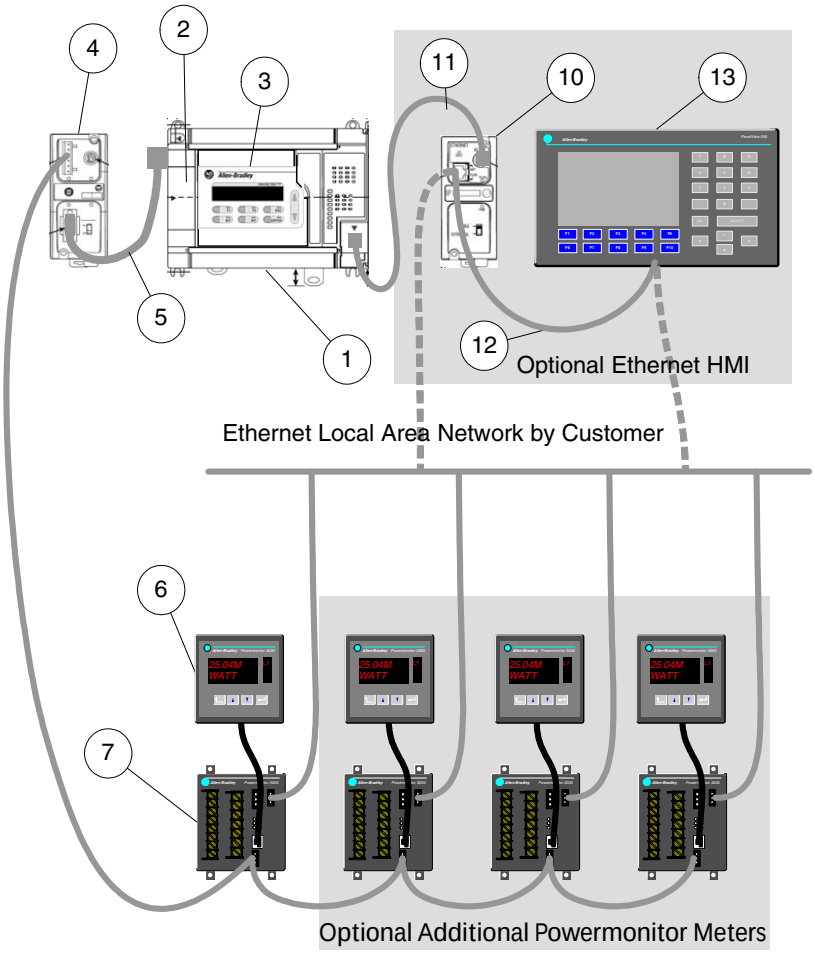
System Architecture

This section illustrates the base system with the serial and Ethernet options.

Base System with Serial Options



Base System with Ethernet Options



TIP Ethernet crossover cable (12) is used if there is no connection to a local area network.

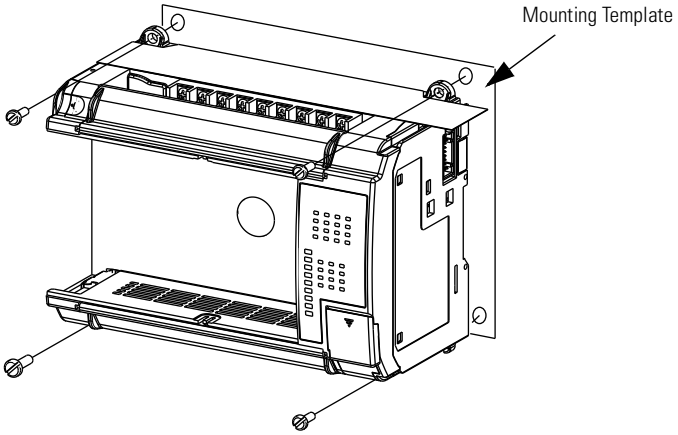
Assemble, Mount, and Connect Your Controller

This section describes how to mount the MicroLogix 1500 controller and connect it to an AIC+ interface and PanelView module for use with the capacitor bank controller.

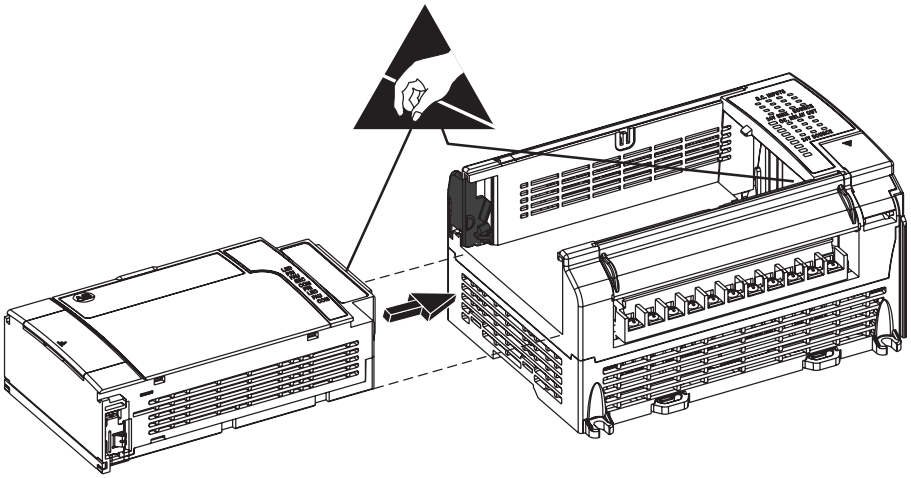
MicroLogix 1500 Controller (All Configurations)

TIP Please refer to Publication 1746-UM001, Chapter 2, for information on performing these tasks.

1. Mount the MicroLogix 1500 base unit (1).

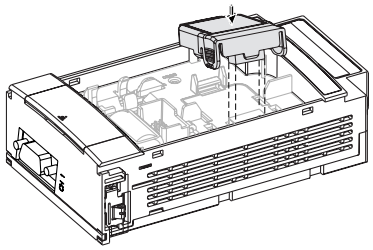


2. Install the MicroLogix 1500 processor module (2).

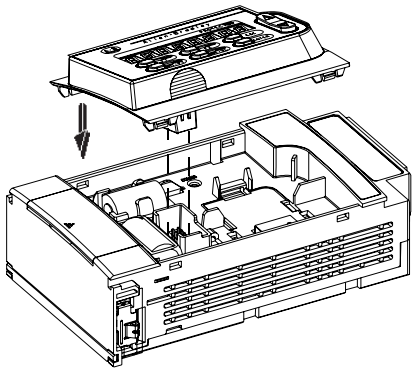


3. Install the MicroLogix memory module (7a).

   This module may be found packaged with the Powermonitor meter (7).



4. Install the data access terminal (3).



5. Connect the MicroLogix 1500 controller to 120V ac control power, earth ground, capacitor step contactors (or interposing relays as required), and an alarm circuit as shown in the wiring diagram.

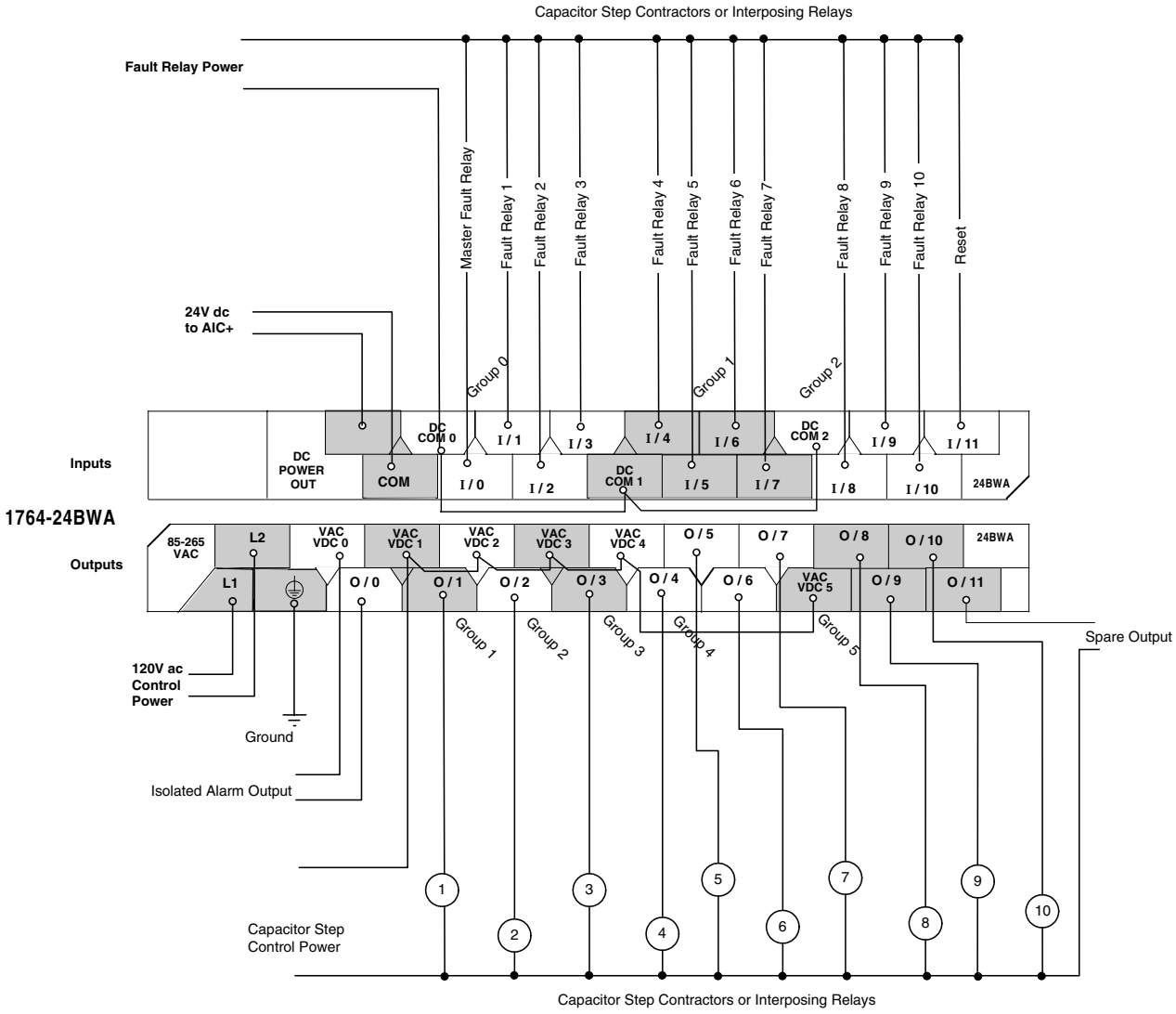
Wire the Controller

Fault-protection relays can be used to immediately discharge all or specific capacitor steps during a fault occurrence. Input 0 is wired to a normally closed fault-protection relay and discharges all capacitor steps during a fault occurrence (low-state condition). Inputs 1… 10 are wired to normally closed fault-protection relays, and discharges its respective capacitor step during a fault occurrence (low-state condition). If fault protection is not being used for a specific capacitor step, then that respective input is wired closed using the controller supplied 24V dc power.

A normally-open momentary pushbutton is wired to Input 11. This pushbutton is used to reset the controller after a fault occurrence.

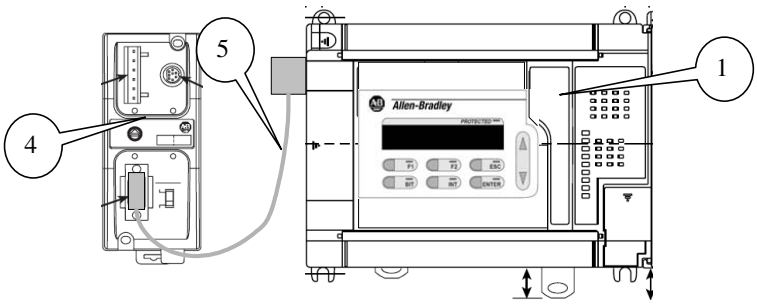
Output 0 is used as an alarm relay and is wired normally open to an external alarm indicator. Output 1…10 is wired to normally-open contactors for each respective capacitor step.

Controller Wiring Diagram



AIC + Interface Converter (All Configurations)

1. Mount the AIC+ communications converter (4) within 45 cm (18 in.) of the left edge of the MicroLogix 1500 controller.



2. Connect the DB9 to DB9 cable (5) between Port 1 of the AIC+ (4) and Channel 1 of the MicroLogix 1500 controller (1).

3. Connect a source of 24V dc to the control power terminals on the bottom of the AIC+.

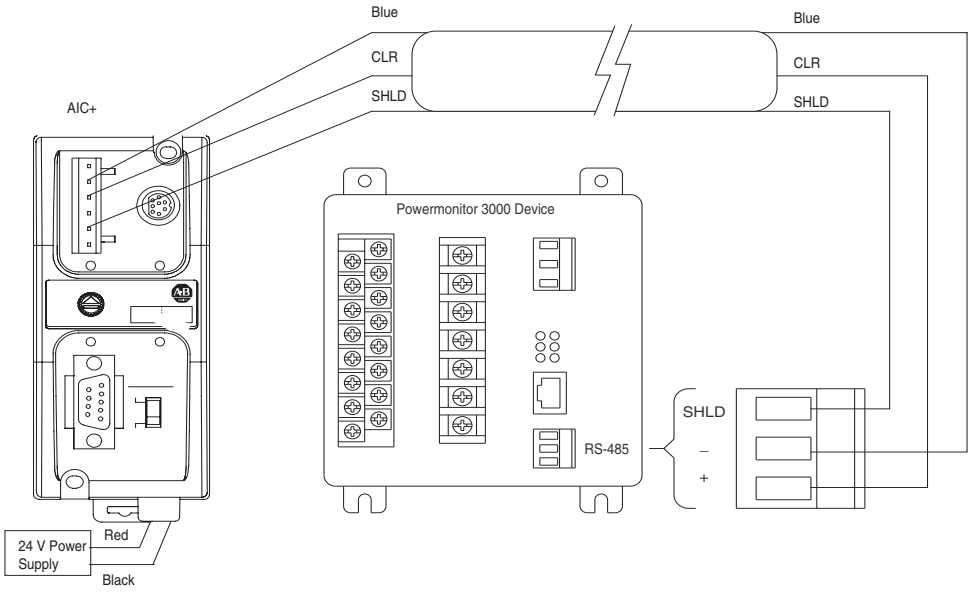
   The 24V dc power may be obtained from the DC Power Out terminals on the MicroLogix 1500 controller.

4. Verify that the DC Source switch is in the External position and that the Baud Rate selector is set to 'Auto'.

Powermonitor Meter (All Configurations)

1. Mount the Powermonitor meter (7) within 1200 m (4000 ft) of the AIC+ communications converter (4).

2. Use a 2-conductor shielded cable, that you provide, to connect the AIC+ RS-485 port to the Powermonitor RS-485 port.



AIC+	Powermonitor 3000 Meter
A	-
B	+
SHLD	SHLD

3. Connect any additional, optional Powermonitor meters RS-485 ports in a daisy-chain fashion, + to +, - to -, Shld to Shld.

In certain cases, terminating resistors may improve communications robustness.

Refer to publication 1404-IN007 for more information.

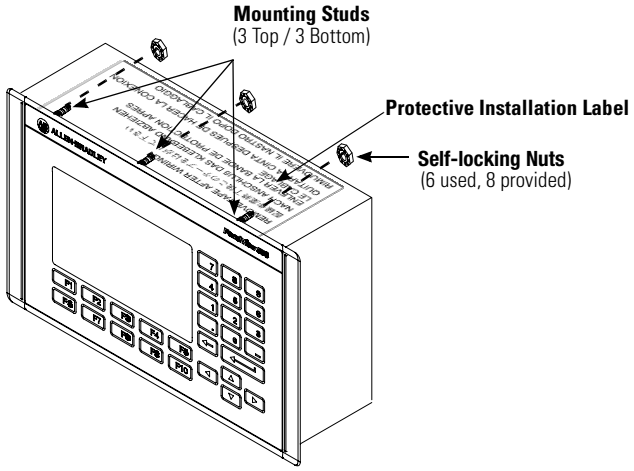
4. Connect the Powermonitor meter to the power circuit, control power, and earth ground.

See the instructions found in publication 1404-IN007.

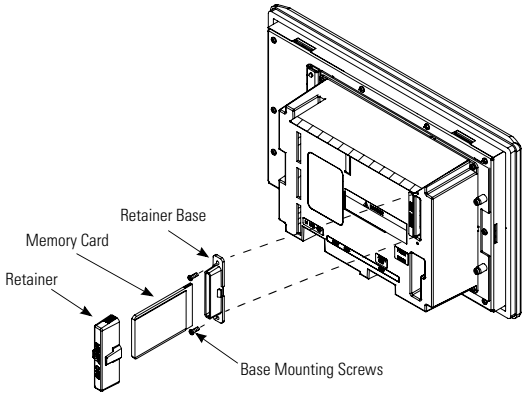
PanelView 550 Serial Terminal (Serial HMI options)

1. Mount the PanelView 550 HMI terminal in a suitable cutout within 5 m (16 ft) of the MicroLogix controller.

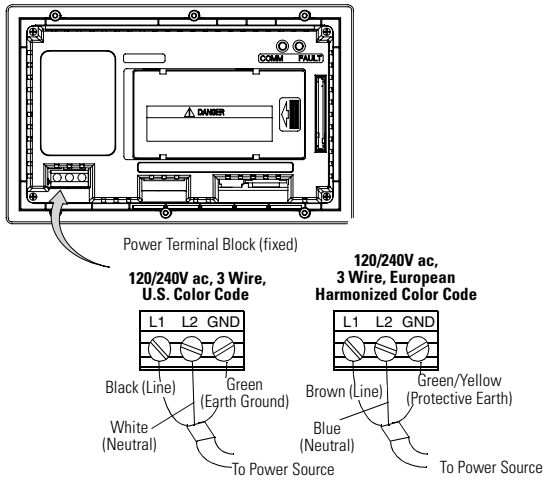
   Refer to publication 2711-IN009 for detailed installation instructions.



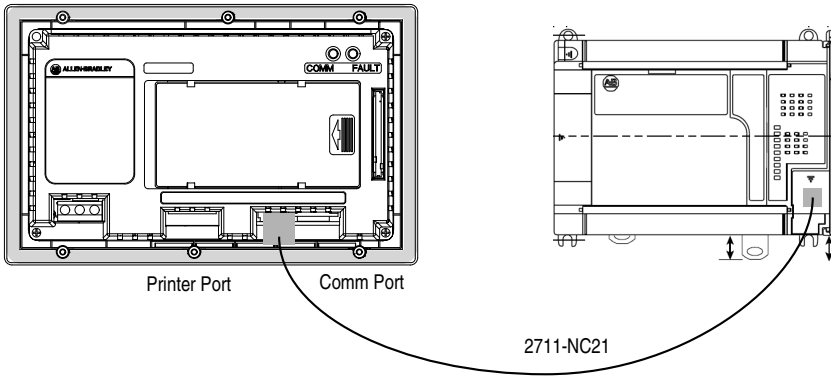
2. Install the memory card and retainer.



3. Connect 120V ac control power and earth ground.



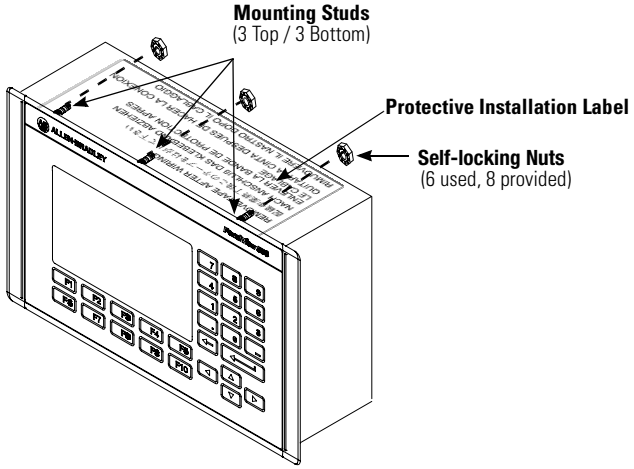
4. Connect the communications cable between the MicroLogix 1500 controller Channel 0 and the PanelView 550 terminal serial port.



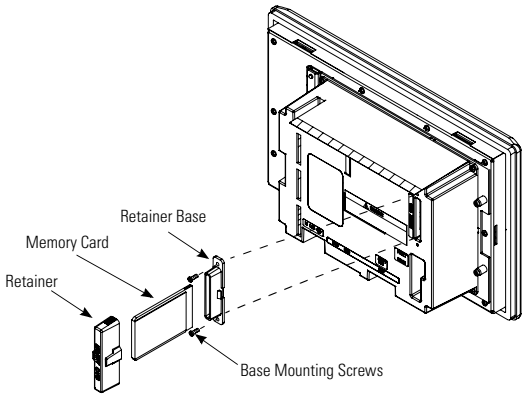
PanelView 550 Ethernet Terminal (Ethernet HMI Option)

1. Mount the PanelView 550 HMI terminal in a suitable cutout within 100 m (328 ft) of the MicroLogix controller.

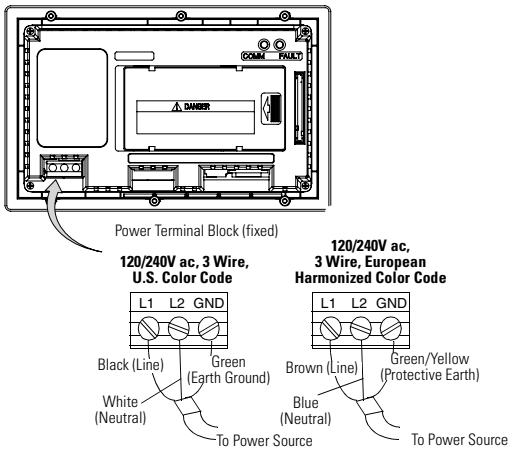
   Refer to publication 2711-IN009 for detailed installation instructions.



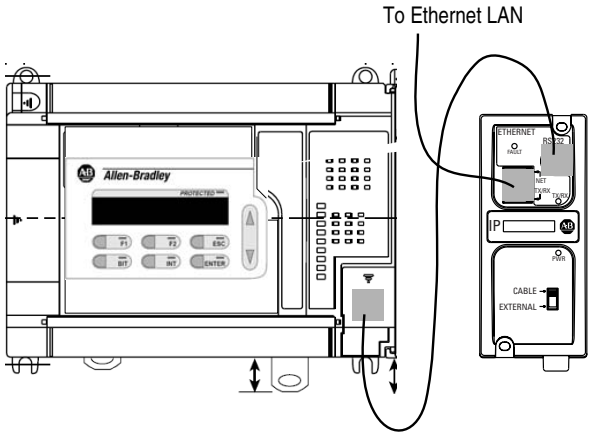
2. Install the memory card (7b, packed with the Powermonitor meter) and retainer.



3. Connect 120V ac control power and earth ground.



4. Install the Ethernet interface module (9) within 45 cm (18 in.) of the Channel 0 connector on the MicroLogix 1500 controller (1).



5. Verify that the DC Source switch on the Ethernet interface module is in the Cable position.

6. Connect the cable (11) between Channel 0 of the MicroLogix 1500 controller and the Ethernet interface module.

7. Connect the PanelView 550 terminal to the Ethernet interface module using the Ethernet crossover cable (12) if the system will not be connected to a local area network.

8. Connect both the PanelView 550 terminal and the Ethernet interface module to the Ethernet local area network via a suitable hub or switch using user-provided CAT5 Ethernet cables if the system will be connected to a local area network.

Configuration

The capacitor bank controller base unit has been set up to require minimal out-of-box configuration.

The base system has default communications settings. Certain circumstances and options require additional configuration of communications, which may include the use of programming software not included with the controller.

You are required to configure the Powermonitor meters to coordinate them to the power circuit in the base unit and all options. Configuration of the Powermonitor meter is performed using the display module.

The controller requires configuration to coordinate it to the number and size of steps that exist in the capacitor bank being controlled, as well as the desired operating mode and other selections. Use the data access terminal (DAT) or the optional PanelView 550 operator terminal to configure the controller.

ATTENTION

Do not operate the capacitor bank controller without first configuring it to suit the controlled capacitor bank and system options. Unpredictable operation, including undesirable power system effects, may result.

Communications Configuration

The following sections provide information on configuring communications for the components.

Base Unit

Communications settings are factory configured. The MicroLogix 1500 controller settings are contained in the EEPROM memory module. Powermonitor meter settings are stored in onboard non-volatile memory (NVRAM). Configuration settings are listed below.

Communications Settings

Device / Parameter	MicroLogix 1500 Controller Chan 0[1]	MicroLogix 1500 Controller Chan 1	Powermonitor Meter 1
Protocol	DF1 Full Duplex	DF1 Half-duplex Master	DF1 Half-duplex Slave[1]
Baud	19,200	19,200[1]	19,200[1]
Source ID / Node Address	1	0	101
Parity / Stop Bits	None / 1	None / 1[1]	None / 1[1]
Handshaking	None	None[1]	None[1]
Error Checking	CRC	CRC[1]	CRC[1]

[1] Default or out-of-box settings.

Serial HMI Option

Communications settings for the PanelView 550 are factory configured and stored on the flash memory card.

PanelView 550 Configuration Settings

Device / Parameter	PanelView 550 Operator Terminal
Protocol	DF1 Full Duplex
Baud	19,200
Source ID / Node Address	2
Parity / Stop Bits	None / 1
Handshaking	None
Error Checking	CRC

Ethernet HMI Option

This option allows the PanelView 550 terminal to connect to your Ethernet network. It obtains data from the MicroLogix 1500 controller through an Ethernet interface module and your local area network. The MicroLogix 1500 controller obtains data from the Powermonitor meters through its Channel 1 serial port, in the identical way as the base unit and serial HMI options.

Default communications settings are factory configured.

PanelView 550 Ethernet Configuration Settings

Device / Parameter	MicroLogix 1500 Controller via NET-ENI	PanelView 550 Operator Terminal	Powermonitor Meter 1
IP Address	192.168.0.100	192.168.0.105	192.168.0.101
Subnet Mask	255.255.255.0	255.255.255.0	255.255.255.0
Default Gateway	192.168.0.1	192.168.0.1	192.168.0.1

To change from the default Ethernet addresses, additional software is required.

The ENI Utility is a free download used to configure the Ethernet interface module.

The ENI Utility can be found at:
http://www.ab.com/micrologix. Follow the links to Get Software and EtherNet/IP and DeviceNet Interface Configuration Utilities.

For information on using the ENI utility, please refer to Rockwell Automation Knowledgebase article A19540 - Quick Start -- Getting started with using the ENI Utility.

You need to supply 24V dc power to the Ethernet Interface while using the ENI utility since the cable to the MicroLogix 1500 controller is disconnected. After reconfiguring the Ethernet address, cycle power to the Ethernet interface module.

Changing from the default addresses in the Powermonitor meters must be done using the Powermonitor display module.

Refer to Powermonitor Meter Configuration on page 23.

Changing the PanelView 550 communications settings requires the use of PanelBuilder32 software, which is purchased from your local Allen-Bradley representative or distributor.

Additional Powermonitor Meters Option

The capacitor bank controller base system and HMI options provide for the addition of up to three more Powermonitor meters. The MicroLogix 1500 controller logic is designed to communicate with Powermonitor meters that have the following communications settings. If Ethernet Powermonitor meters are added to the system, their Ethernet addressing should be configured per your networking requirements.

Powermonitor Ethernet Communication Settings

Device / Parameter	Powermonitor Meter 2	Powermonitor Meter 3	Powermonitor Meter 4
Node Address	102	103	104
IP Address(1)	192.168.0.UnitID	192.168.0.UnitID	192.168.0.UnitID
Subnet Mask	255.255.255.0	255.255.255.0	255.255.255.0
Default Gateway	192.168.0.1	192.168.0.1	192.168.0.1

(1) The Unit ID is listed on the Powermonitor nameplate.

Powermonitor meter communications settings are changed using the Powermonitor display module.

Please refer to Powermonitor Meter Configuration Parameters table.

Powermonitor Meter Configuration

The table below lists the configuration parameters that must be set up for correct operation of the capacitor bank controller.

For additional information regarding Powermonitor meter configuration, please refer to the Powermonitor 3000 User Manual, publication 1404-UM001.

Powermonitor Meter Configuration Parameters

Parameter	PM 1	PM 2(4)	PM 3(4)	PM 4(4)
Wiring mode(1)				
PT (VT) primary voltage				
PT (VT) secondary voltage				
CT primary current				
I4 primary current				
RS-485 node number	101(3)	102	103	104
IP address(2)	192.168.0.101			
Subnet mask(2)	255.255.255.0			
Default gateway address(2)	192.168.0.1			

(1) Wiring mode must be Wye when using NEU or Retro CTPT mode.

(2) Applies only to Ethernet Powermonitor meter options.

(3) Default factory setting for base unit.

(4) Optional additional Powermonitor meters.

Parameter Descriptions

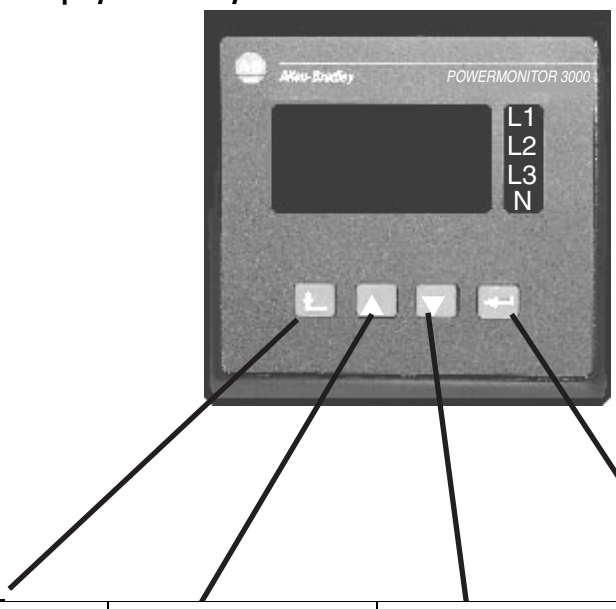
- **Wiring mode –** selected to match the physical connections to the power system
  - Delta 3 CT
  - Delta 2 CT
  - Direct delta 3 CT
  - Direct delta 2 CT
  - Open delta 3 CT
  - Open delta 2 CT
  - Wye (default)
  - Single phase
- **PT (VT) primary voltage –** reflects the voltage rating on the high side of the potential/voltage transformers. Range 1…10,000,000 V, default 480
- **PT (VT) secondary voltage –** reflects the voltage rating on the low side of the potential/voltage transformers. Range 1…600 V, default 480
- **CT primary current –** reflects the current rating on the high side of the phase current transformers. Range 1…10,000,000 A, default 5. The CT secondary current is also adjustable but the default value of 5 A is standard
- **I4 primary current –** reflects the current rating on the high side of the neutral current transformer. Range and defaults are the same as CT primary current setting
- **RS-485 node number** – sets the communications address on the RS-485 network to the MicroLogix 1500 controller. Factory-set at 101 for PM 1, must be user configured for optional PMs 2 …4. Range 1…247, default is the Unit ID
- **IP address, subnet mask, default gateway** – Ethernet port settings required for communications with the user's local area network

Set Parameters with the Powermonitor Display Module

The Basic Configuration table contains the configuration parameters needed for initial setup of the Powermonitor meter in the base system.

The table and diagram below describe the basic functionality of the Powermonitor display module.

Display Module Key Function

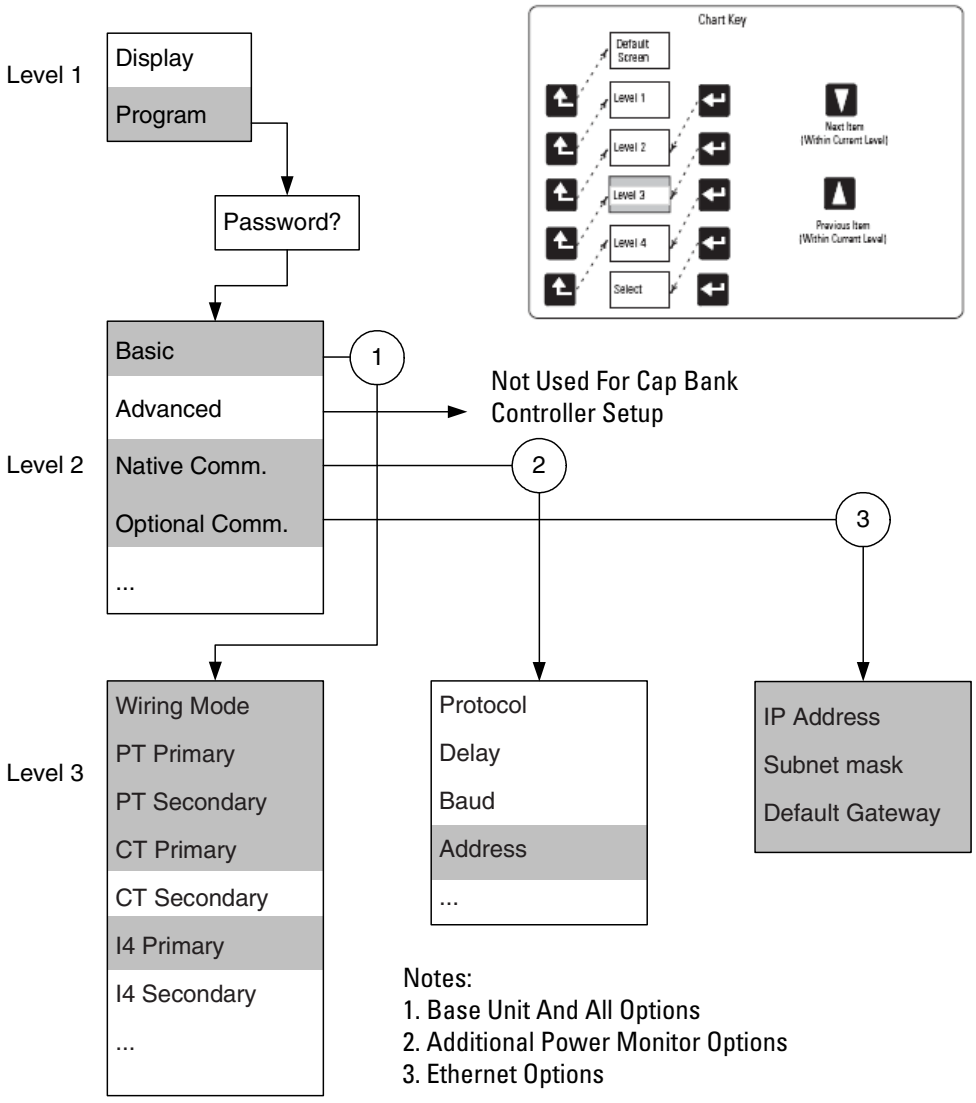


	Escape Key	Up Arrow Key	Down Arrow Key	Enter Key
Display mode	Returns to parent menu	Steps back to the previous parameter/menu in the list	Steps forward to the next parameter/menu in the list	Steps into a sub-menu or sets as default screen
Program mode	Returns to parent menu	Steps back to the previous parameter/menu in the list	Steps forward to the next parameter/menu in the list	Steps into a sub-menu, selects the parameter to be modified or changes to Edit mode
Edit mode	Cancels changes to the parameter, restores the existing value, and returns to Program mode	Increments the parameter/menu value	Decrements the parameter value	Saves the parameter change to Master Module and returns to Program mode

The following flow chart shows the menu structure of the Powermonitor meter parameters to be configured for the base unit and various options. Use the Enter and Escape keys to move between levels and the arrow keys to select options within a level. Once the parameter you wish to configure is selected, press the Enter key to edit the parameter. In Edit mode, the parameter's displayed value will blink. Use the arrow keys to change the value of the displayed parameter. Press the Enter key to save the displayed value in the Powermonitor meter. The display momentarily displays the previous value then the new value.

In the chart, the configuration items for the capacitor bank controller are highlighted with a grey background.

Menu Flowchart



Controller Configuration

You may view and edit the first 48 of the CAP Bank Controller parameters using the data access terminal (DAT). The optional PanelView 550 terminal in either of the HMI options provides configuration screens for viewing and editing the parameters, as indicated in the Control and Status Parameter table (Screens: 1 = Configuration, X1 = Extended Configuration 1, X2 = Extended Configuration 2). The range of each integer parameter is 0 … 32,768 unless otherwise specified. The parameters are stored in contiguous locations in a data file (N7:0 … 47) in the controller.

Control and Status Parameters

Address	Parameter	Unit	Description	Range	Default	DAT INT	PanelView Screen
N7:0	Capacitor Step 1 - Measured Size	kVAR	Measured and averaged capacitor size for each step		-	0	Configuration
N7:1	Capacitor Step 2 - Measured Size	kVAR			-	1	Configuration
N7:2	Capacitor Step 3 - Measured Size	kVAR			-	2	Configuration
N7:3	Capacitor Step 4 - Measured Size	kVAR			-	3	Configuration
N7:4	Capacitor Step 5 - Measured Size	kVAR			-	4	Configuration
N7:5	Capacitor Step 6 - Measured Size	kVAR			-	5	Configuration
N7:6	Capacitor Step 7 - Measured Size	kVAR			-	6	Configuration
N7:7	Capacitor Step 8 - Measured Size	kVAR			-	7	Configuration
N7:8	Capacitor Step 9 - Measured Size	kVAR			-	8	Configuration
N7:9	Capacitor Step 10 - Measured Size	kVAR			-	9	Configuration

Control and Status Parameters

Address	Parameter	Unit	Description	Range	Default	DAT INT	PanelView Screen
N7:10	Capacitor Step 1 - Effective Size	kVAR	Nameplate capacitor size for each step		50	10	Configuration
N7:11	Capacitor Step 2 - Effective Size	kVAR			50	11	Configuration
N7:12	Capacitor Step 3 - Effective Size	kVAR			50	12	Configuration
N7:13	Capacitor Step 4 - Effective Size	kVAR			50	13	Configuration
N7:14	Capacitor Step 5 - Effective Size	kVAR			50	14	Configuration
N7:15	Capacitor Step 6 - Effective Size	kVAR			50	15	Configuration
N7:16	Capacitor Step 7 - Effective Size	kVAR			50	16	Configuration
N7:17	Capacitor Step 8 - Effective Size	kVAR			50	17	Configuration
N7:18	Capacitor Step 9 - Effective Size	kVAR			50	18	Configuration
N7:19	Capacitor Step 10 - Effective Size	kVAR			50	19	Configuration
N7:30	Capacitor Discharge Time	seconds	The amount of time after a capacitor step is turned off, before a capacitor step is considered fully discharged		60	30	Configuration
N7:31	Nominal Voltage	volts	The nominal bus voltage of the system		480	31	Ext Configuration 1

Control and Status Parameters

Address	Parameter	Unit	Description	Range	Default	DAT INT	PanelView Screen
N7:32	Voltage Threshold - High & Low	%	The voltage percentage from nominal, that will determine high and low limits for alarming	1 - 10	5	32	Ext Configuration 1
N7:33	%THD Voltage Setpoint	%	The %THD at which the controller acts to reduce voltage % THD	0 - 100	3	33	Ext Configuration 1
N7:34	Lead Deadband	kVAR	The leading kVAR limit allowed for the system, before the controller acts to correct lead, typically 33% of smallest capacitor step		20	34	Configuration
N7:35	Lag Deadband	kVAR	The lagging kVAR limit allowed for the system, before the controller acts to correct lag, typically 66% of largest capacitor step		35	35	Configuration
N7:36	Step Tolerance Low Limit	%	The kVAR percentage of effective, that will determine low limits for each capacitor step	0 - 10	5	36	Ext Configuration 2
N7:37	Power Factor Out-of-Range Time	seconds	The amount of time the system kVAR must be out of the range of the lead or lag deadband, before the controller acts to correct		60	37	Ext Configuration 1
N7:38	%THD Alarm Time	seconds	The amount of time after all capacitor steps are actuated, and %THD is still above the setpoint limit, before setting the %THD High Alarm			38	Ext Configuration 1
N7:39	Step Tolerance Time	seconds	The amount of time after a capacitor step is actuated, before taking a sample reading of the system kVAR difference, to determine if the capacitor step is above the step tolerance low limit			39	Ext Configuration 2
N7:40	Voltage High In-Range Time	seconds	The amount of time the bus voltage must be below the high limit before resetting the Voltage High Alarm			40	Ext Configuration 1
N7:41	Voltage Low In-Range Time	seconds	The amount of time the bus voltage must be above the low limit before resetting the Voltage Low Alarm			41	Ext Configuration 1
N7:42	Voltage In-Range Time	seconds	The amount of time after the Voltage High and Voltage Low alarms have been reset, before signifying that the voltage is in an acceptable range.			42	Ext Configuration 1

Control and Status Parameters

Address	Parameter	Unit	Description	Range	Default	DAT INT	PanelView Screen
N7:43	Control Word[1]		This is the control word for the capacitor bank controller. The first three (3) bits of the control word is used to set the CTPT Mode. Bit 4 is used to initiate a restore of factory defaults. This should be treated as a momentary state. Bit 5 is used to initiate the step size buffer. This bit should also be treated as a momentary state. Bit 6 is used for disabling step tolerance. The BCD value for each bit is available for easy setup. Examples - CTPT Mode 2 and Disable Step Tolerance = 68 - CTPT Mode 0 and Restore Factory Defaults = 17 to initiate a restore, then 1. - CTPT Mode 1 and Initiate Step Buffer = 34 to initiate step buffer, then 2			43	Ext Configuration 2
N7:44	Unbalance Alarm Time	seconds	The amount of time before alarming and resetting the Unbalance Alarm flag			44	Ext Configuration 1
N7:45	Number of Powermonitor meters		The number of Powermonitor meters to include in the aggregate kW and kVAR calculations			45	Configuration
N7:46	Number of Capacitor Steps		The number of capacitor steps to be controlled			46	Configuration
N7:47	Operating Mode		The operating mode: 0 - Manual 1 - Linear 2 - Balanced 3 - Best Fit 4 - User Defined 5 - % Voltage THD			47	Configuration
N7:59	Number of Samples		The number of kVAR samples to average together when auto-configuring capacitor step sizes.	1 - 10	5	-	Ext Configuration 1

[1] Please see the Control Word table.

Control Word

Bit	Parameter	BCD Value
0	CTPT Mode 0 - Normal	1
1	CTPT Mode 1 - Neutral	2
2	CTPT Mode 2 - Retro	4
3		8

Control Word

Bit	Parameter	BCD Value
4	Restore Factory Defaults	16
5	Initialize Step Buffer	32
6	Disable Step Tolerance; 0 = False, 1 = True	64
7	Enable Input Mode; 0 = False, 1 = True	128

Use the DAT for Configuration

The data access terminal (DAT) provides a basic configuration interface for the capacitor bank controller. In Integer mode, the DAT provides read/write access to the configuration parameters listed in the Control and Status Parameters table. You may also use the DAT in Bit mode to automatically detect and configure the capacitor-bank step sizes.

The DAT enters the Bit mode automatically after applying power. Bit mode can also be selected by pressing the BIT key. If Bit mode was already active, the DAT displays the last bit element monitored. If Integer mode was active, the DAT displays the first bit element, after a brief delay during which a working message appears.

To select Integer mode, press the INT key. If Integer mode was already active, the DAT displays the last integer element monitored. If Bit mode had been active, the DAT displays the first integer element after a brief delay during which a working message appears.

Auto-configure Capacitor Step Sizes

Use the DAT to automatically configure the step sizes.

1. Select Bit mode.
2. Scroll to and select bit 40.
3. Press the Enter key to edit the bit.
4. Use the up/down key to change the value of the bit to 1.

   TIP If the data is protected or undefined, pressing the up/down key scrolls to the next data element.

5. Press the Enter key to store the new value.

   Esc or INT/Bit keys discard the new value.

The auto-configure process begins. During this process, the controller energizes each capacitor-bank step for a short time, measures the steps kVARs and records the value. This process repeats several times and the results of each trial are averaged. When the process is complete, the averaged values are copied to the Effinal_StepSize_Sn parameters and the Auto_Detect_Cap_Size flag is reset.

You must manually configure any parameters that need to change from the default values listed in the table.

Input Interlock Mode

The Input Interlock mode allows fault protection for each capacitor step through the use of fault-protection relays. Wire normally closed fault-protection relays to each input from 0…10 of the controller. Wire a normally-open momentary pushbutton to Input 11. This pushbutton serves as a reset button.

During a fault occurrence, the controller discharges and locks-out the respective capacitor step associated with the fault relay that tripped. The fault-protection relay wired to Input 0 discharges and locks-out all capacitor steps. The remaining fault-protection relays discharge and lock-out their respective capacitor step (that is, Input 1 discharges and locks-out capacitor step 1).

In order to place a capacitor step back into the sequence, a fault must not be present for that step, and a reset must be initiated by pushing the Reset pushbutton.

Manually Set Configuration Parameters

Use the DAT to manually change the controller configuration parameters.

1. Select Integer mode.
2. Scroll to and select the desired configuration parameter.

   Refer to the Control and Status Parameters table on page 27.
3. Press the Enter key to edit the parameter.
4. Use the up/down keys to change the value of the parameter.

TIP If the data is protected or undefined, pressing the up/down key scrolls to the next data element.

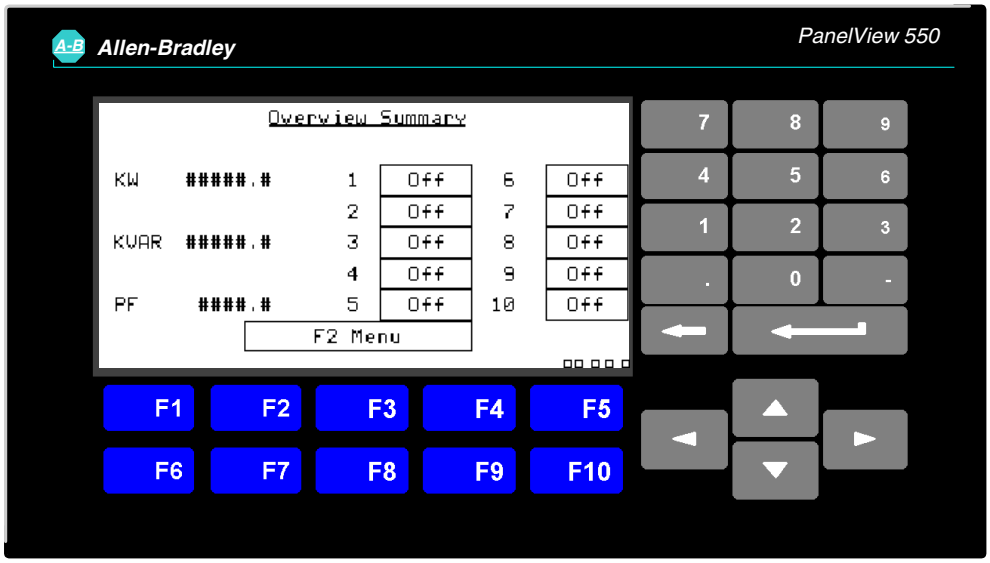
5. Press the Enter key to store the new value.

   Esc or INT/Bit keys will discard the new value.

6. Repeat steps 2…5 as needed.

Configuration with the PanelView 550 Terminal (Optional HMI Only)

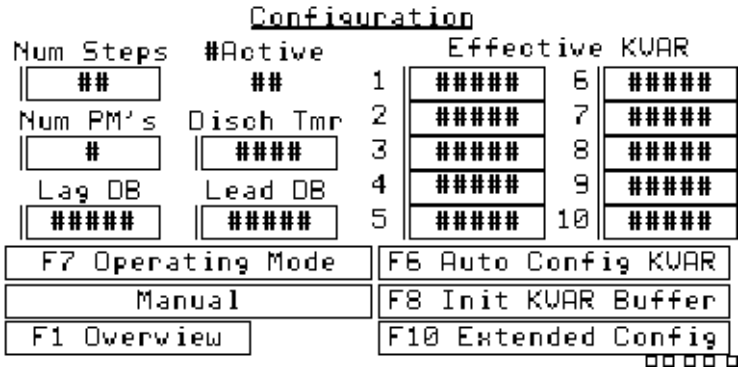
The optional PanelView 550 terminal provides you with a more user-friendly interface to the capacitor bank controller. Use the function keys to navigate through the screens and enter data as needed using the keypad.



Configure the capacitor bank controller using the optional PanelView terminal.

1. Press the F2 key to view the Menu from the Overview screen.

2. Press F10 to view the Configuration screen from the Menu.



The controller tags available on the Configuration screen are shown below in their relative location on the screen.

Num_Steps	StepsActive	Eff_StepSize_S1	Eff_StepSize_S6
		Eff_StepSize_S2	Eff_StepSize_S7
Num_PMs	DischgTimerPreset	Eff_StepSize_S3	Eff_StepSize_S8
		Eff_StepSize_S4	Eff_StepSize_S9
kVAR_Lead_DB	kVAR_Lag_DB	Eff_StepSize_S5	Eff_StepSize_S10
Mode		Auto_Detect_Cap_Size	
		Initialize_Step_Buffer	

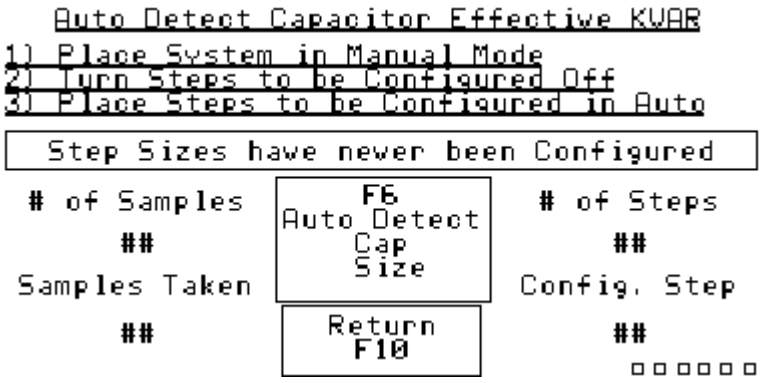
3. Press the Direction keys to move the cursor over the desired field and press the Enter key.

4. Enter the desired value using the keypad and press Enter to store the new value.

   Pressing the Backspace key cancels a change.

5. Press F6 to navigate to the Auto Configure Effective kVAR process.

TIP The number of measurements to average for each step is entered on the Extended Configuration Screen #2 (F10).



6. Press F6 to initiate the auto-configuration process.

7. When done, press F10 to return to the Configuration screen.

8. Select the desired operating mode by entering the number or by selecting the description in the list box.

   The new value is displayed in both formats.

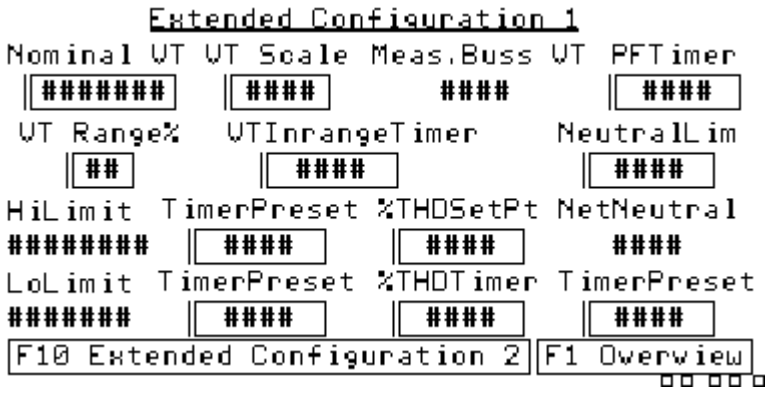
9. To select the mode, move the curser over the list box and press Enter.

10. Press the Direction keys to scroll through the selections.

11. Press Enter again to select the displayed mode.

    F1 returns to the Overview screen.

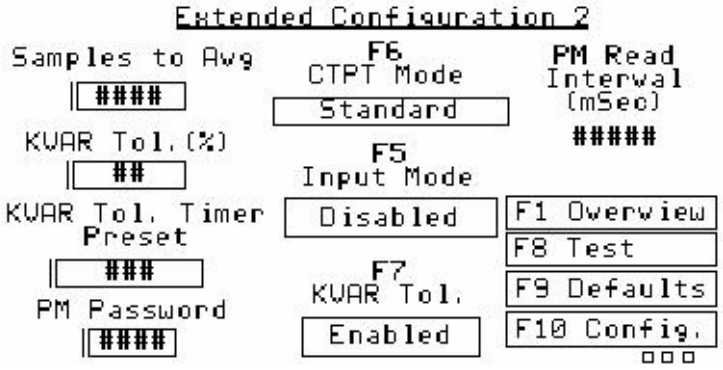
F10 navigates to the first Extended Configuration screen. This screen operates in the same way as the initial configuration screen.



The controller tags available on the Configuration screen are shown below in their relative location on the screen.

NominalVoltage	Nominal_Voltage_Scale	Bus_Volts	PF_inRange_Timer_Preset
VoltageRange	InRangeTimerPreset		Unbalanced_Limit
HighLimit	HighLimitTimerPreset	%THD_V_SetPoint	Net_Current
LowLimit	LowLimitTimerPreset	%THD_Timer_Preset	Unbalance_Timer_Preset

12. Press F10 to navigate to the Extended Configuration 2 screen from the Extended Configuration 1 screen.



The controller tags available on the Configuration screen are shown below in their relative location on the screen.

Number of Samples	CTPT Mode	Powermonitor Heartbeat
Step Tolerance Low Limit	Input Mode Disable/Enable	
Step Tolerance Time		Restore Defaults
Powermonitor Password	Kvar Tolerance Disable/Enable	

Operation

Introduction

The capacitor bank controller gathers real- and reactive-power data using one or more Powermonitor meters. The processor manipulates data in engineering units of kVAR and kW. The unit does not directly control power factor, but rather works to actively minimize imported and exported kVAR. The net result of this philosophy indirectly controls power factor and minimizes voltage excursions associated with excessive kVAR export.

The capacitor bank controller can accommodate up to four different utility feeds and/or generators. Each feed requires an individual Powermonitor meter. The unit sums the kW and kVAR readings from each of the Powermonitor meters to arrive at an aggregate kVAR so that a single capacitor bank could be used to compensate several feeds simultaneously.

The traditional C/k ratio is not required for the capacitor bank controller since we are working in engineering units within the processor.

Aggregate Power Factor is calculated and displayed using the following formula:

$$PF_{Aggregate} = \frac{KW_{Aggregate}}{\sqrt{KW^2_{Aggregate} + KVAR^2_{Aggregate}}}$$

The Powermonitor meter data is gathered with RS-485 ports using the DF-1 half-duplex protocol at a data rate of 19.2 Kbps.

Operating Modes

Each capacitor step can be individually selected to on, off, or auto status. The capacitor discharge-timer interlock is in effect in Manual mode to prevent capacitor bank damage. In Auto mode, a step is available to any of the automatic sequences described below. In the On or Off mode, a step is unavailable to any automatic operating mode.

- **Manual** (mode = 0) – This mode disables all automatic operating modes.

  Manual mode is the default configuration. All capacitor steps have a default configuration of auto.

- **Linear** (mode = 1) – This mode of operation switches the capacitor steps on and off in first-in, last-out (FILO) order. That is, the first step on is the last step turned off. This is most useful when all the capacitor steps are of similar sized.
- **Balanced** (mode = 2) – This mode counts the number of opening operations on each capacitor step and switch-capacitor steps to balance the number of opening operations equally across all of the employed capacitor steps. This mode is also most useful when all of the steps are of similar size.
- **Best Fit** (mode = 3) – This mode selects capacitor steps to be switched on and off to most closely achieve the target power factor and kVAR needs of the system. When the system's kVAR needs increase, the available step or steps with the closest (aggregated) kVAR rating is added. On decreasing kVAR demand, steps are switched off in similar fashion.
- **Special** (mode = 4) – This mode is reserved for customer-defined switching sequences not described above including voltage, current, and time of day type functions. Special-switching mode might include switching on parameters such as PF, current, voltage, time of day, weekends / weekdays, or seasonal adjustments.

  Refer to Add Special Functionality on page 51.

- **%THD** (mode = 5) – This mode selects capacitor steps to be added in a linear fashion (for example, step 1, step 2) until the %THD_V is below the setpoint for a user-configurable time delay (default 60 seconds). The system will start to remove capacitor steps when the %THD_V is 1% below the setpoint for the user-configurable delay.

CTPT Modes

The CTPT mode configures the capacitor bank controller to be connected to current transformers (CTs) and potential transformers (PTs) in one of three ways:

- 0 = Normal mode - CTs and PTs are installed in a typical three-phase configuration. The controller uses the real- and reactive-power data produced by the power monitor(s) without further processing.
- 1 = NEU mode - One CT wired on the A phase and one PT wired from phase A to neutral are installed on a three-phase circuit. The power monitors must be set up in Wye-wiring mode. The controller multiplies the real- and reactive-power data produced by the power monitors by 3.

- 2 = Retro mode - One CT wired on the A phase and one PT wired from phases B to C are installed on a three-phase circuit. The power monitors must be set up in Wye-wiring mode. The controller swaps the values of the real- and reactive-power data produced by the power monitors and multiplies them by $\sqrt{3}$. This mode is particularly useful in retrofit applications.

Alarms

- **Bad Step** - This alarm indicates a blown fuse and/or loss of capacitor condition. The controller measures actual VAR output from a capacitor step, averages, and compares this value with the original effective capacitor value. When actual VAR is more than the user-configurable StepKvarTolerance (default 5%) below the effective step size for a user-configurable delay (default 30 seconds), the alarm is activated. The alarm is reset when actual VAR output is greater than or equal to the setpoint for the same delay. The step will be latched as tripped/offline if the VAR output falls below 90% of nominal.
- **Target power factor not achieved -** If actual power is less than setpoint for a user-adjustable number of seconds, then set the alarm flag.
- **High and Low Voltage** - If BusVolts is outside either limit, this alarm is activated immediately. After the voltage returns to the proper range for a configurable amount of time, this alarm is reset.
- **%THD_V above setpoint** - If all available steps are added and %THD_V remains above the setpoint longer than the configurable time delay, an alarm will be generated and the system alarm contact closes. The alarm is reset when the %THD_V falls below setpoint for the same period of time.
- **Unbalance** - This alarm is set when the average neutral current exceeds a preset maximum for a configurable period of time. It is reset using the same timer.

Operator Interface

The capacitor bank controller offers three types of operator interface.

- **Data access terminal (DAT) –** A simplistic operator terminal physically attached to the controller that provides read/write access to configuration and operating data. The DAT is provided with the base unit and all optional configurations.
- **Serial PanelView 550 –** A comparatively robust operator interface terminal that provides selectable configuration and operating screens and a keypad for navigation and data entry. Communications with the controller is through a serial point-to-point connection. The serial PanelView is offered in the Serial HMI option only.

- **Ethernet PanelView 550 –** A similar HMI to the serial PanelView but using Ethernet communications, offered with the Ethernet HMI option only.

Data Access Terminal (DAT)

The data access terminal (DAT) provides access to 48 integer and 48 binary data registers.

The Binary (bit) Elements and Integer (Word) Elements tables define how these register assignments are made.

See Control and Status Parameters on page 27 for the Integer (Word) Elements.

Binary (bit) Elements

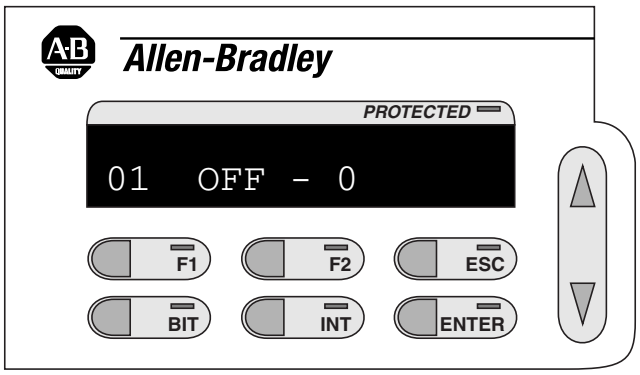
Address	Parameter	Value	DAT BIT	PanelView Screen
B3:0	Capacitor Step 1 - Status	0 = Off, 1 = On	0	Bank Status
B3:1	Capacitor Step 2 - Status		1	
B3:2	Capacitor Step 3 - Status		2	
B3:3	Capacitor Step 4 - Status		3	
B3:4	Capacitor Step 5 - Status		4	
B3:5	Capacitor Step 6 - Status		5	
B3:6	Capacitor Step 7 - Status		6	
B3:7	Capacitor Step 8 - Status		7	
B3:8	Capacitor Step 9 - Status		8	
B3:9	Capacitor Step 10 - Status		9	
B3:10	Capacitor Step 1 - Alarm	0 = No Alarm, 1 = In Alarm	10	
B3:11	Capacitor Step 2 - Alarm		11	
B3:12	Capacitor Step 3 - Alarm		12	
B3:13	Capacitor Step 4 - Alarm		13	
B3:14	Capacitor Step 5 - Alarm		14	
B3:15	Capacitor Step 6 - Alarm		15	
B3:16	Capacitor Step 7 - Alarm		16	
B3:17	Capacitor Step 8 - Alarm		17	
B3:18	Capacitor Step 9 - Alarm		18	
B3:19	Capacitor Step 10 - Alarm		19	

Binary (bit) Elements

Address	Parameter	Value	DAT BIT	PanelView Screen
B3:20	Capacitor Step 1 - Mode	0 = Manual, 1 = Auto	20	Step Control
B3:21	Capacitor Step 2 - Mode		21	
B3:22	Capacitor Step 3 - Mode		22	
B3:23	Capacitor Step 4 - Mode		23	
B3:24	Capacitor Step 5 - Mode	0 = Manual, 1 = Auto	24	Step Control
B3:25	Capacitor Step 6 - Mode		25	
B3:26	Capacitor Step 7 - Mode		26	
B3:27	Capacitor Step 8 - Mode		27	
B3:28	Capacitor Step 9 - Mode		28	
B3:29	Capacitor Step 10 - Mode		29	
B3:30	Capacitor Step 1 - Manual Command	0 = Command Off, 1 = Command On	30	
B3:31	Capacitor Step 2 - Manual Command		31	
B3:32	Capacitor Step 3 - Manual Command		32	
B3:33	Capacitor Step 4 - Manual Command		33	
B3:34	Capacitor Step 5 - Manual Command		34	
B3:35	Capacitor Step 6 - Manual Command		35	
B3:36	Capacitor Step 7 - Manual Command		36	
B3:37	Capacitor Step 8 - Manual Command		37	
B3:38	Capacitor Step 9 - Manual Command		38	
B3:39	Capacitor Step 10 - Manual Command		39	
B3:40	Auto Configure Capacitor Step Sizes	Set to 1 to initiate	40	Configuration
B3:41	System Alarm	0 = No Alarm, 1 = In Alarm	41	Alarm Summary
B3:42	Bad Step Alarm		42	
B3:43	Power Factor Not Achieved Alarm		43	
B3:44	Voltage Alarm		44	
B3:45	% Voltage THD High Alarm		45	
B3:46	Current Unbalance Alarm		46	

EXAMPLE Step 4, Alarm status, is found at bit address 13.

Use the DAT



The data access terminal (DAT) enters the Bit mode automatically after you apply power. Bit mode can also be selected by pressing the BIT key. If Bit mode was already active, the DAT displays the last bit element monitored. If Integer mode was active, the DAT displays the first bit element, after a brief delay during which a working message appears.

Press the INT key to select Integer mode. If Integer mode was already active, the DAT displays the last integer element monitored. If Bit mode had been active, the DAT displays the first integer element after a brief delay during which a working message appears.

To view controller data, select the desired mode (Bit or Integer). Use the up/down keys to scroll to the word or bit address. The address and value of the selected parameter is displayed. If the parameter is read-only, the protected indicator will light.

The DAT checks for controller faults every 10 seconds. When the DAT detects a controller fault, the display shows FL in the element number field and the value of the controller's major fault word (S2:6) is displayed in the value field.

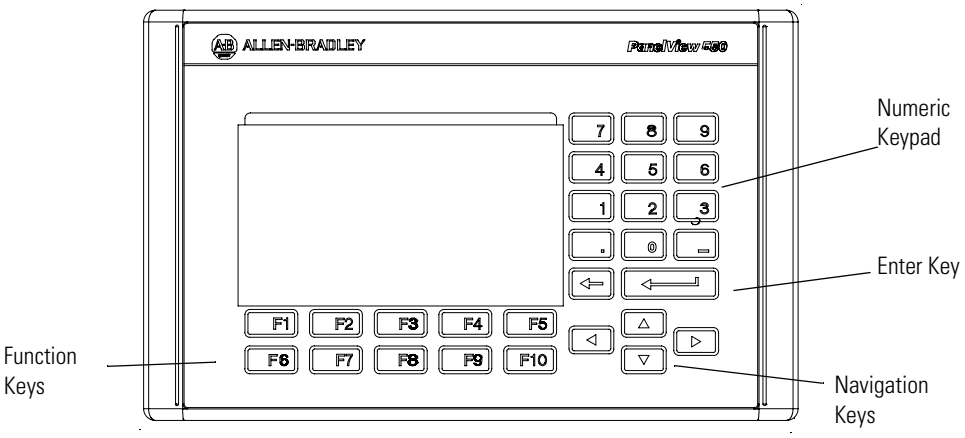
Please refer to the section on configuration for information on using the DAT to edit configuration parameters.

Optional PanelView 550 HMI

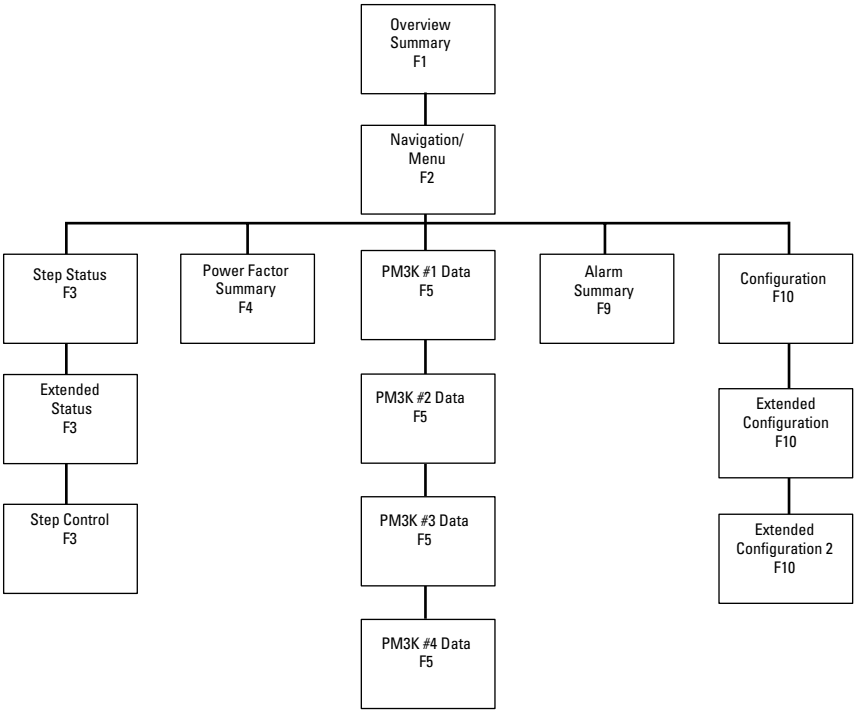
The optional PanelView HMI provides you with a more robust user interface. The following screens are provided.

- Overview Summary

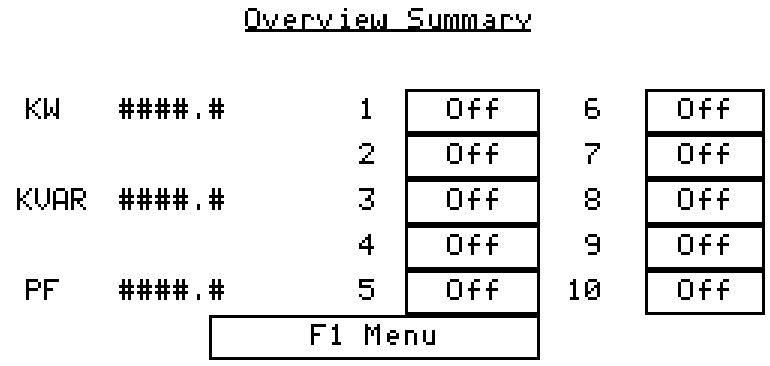
- Navigation / Menu
- Bank Status
- Extended Status
- Step Control
- Power Factor Summary
- Powermonitoring Data x4
- Alarm Summary
- System Configuration



Screen Navigation Tree

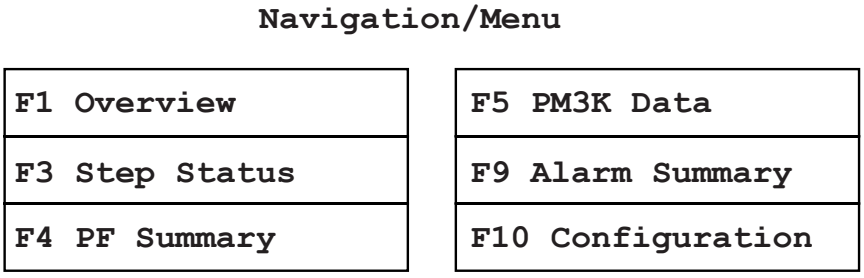


Overview Summary Screen

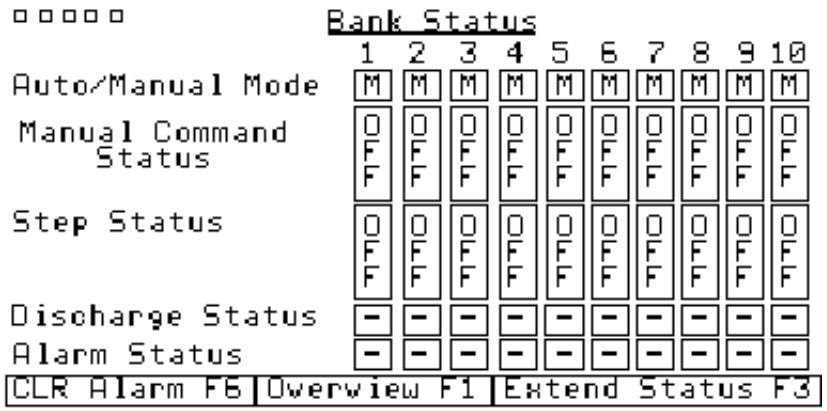


This is the home screen and displays after you apply power. Press the F1 function key to navigate to the Menu screen.

Navigation / Menu Screen



Bank Status Screen



The status for the steps is listed in vertical columns from 1…10. There are no configurations on this screen. It displays status data only.

Mode: A = Automatic, which means the step is controlled based on the operation mode selected. M = Manual, which means you can force the step on or off via the keypad.

Step Status: 1 = On, 0 = Off.

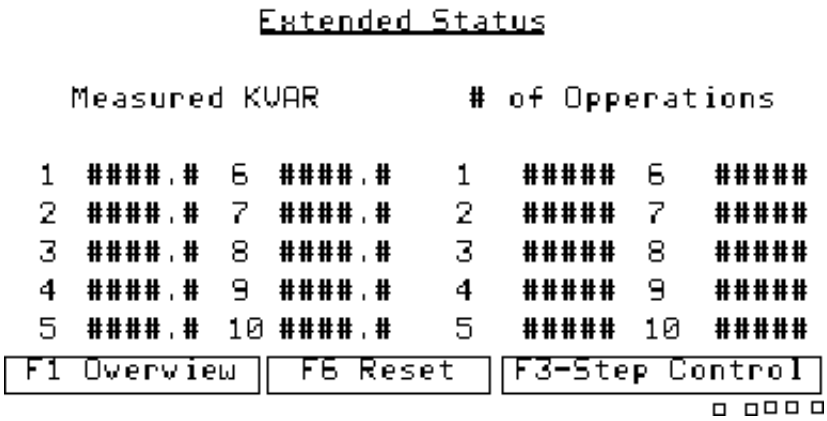
Discharge Status: '-' = Not Discharging, D = Discharging.

Alarm: '-' = No Alarm, '*' = In Alarm.

You can press the F3 function key to navigate to the Extended Status Screen.

Press the F1 function key to return to the Overview Summary Screen.

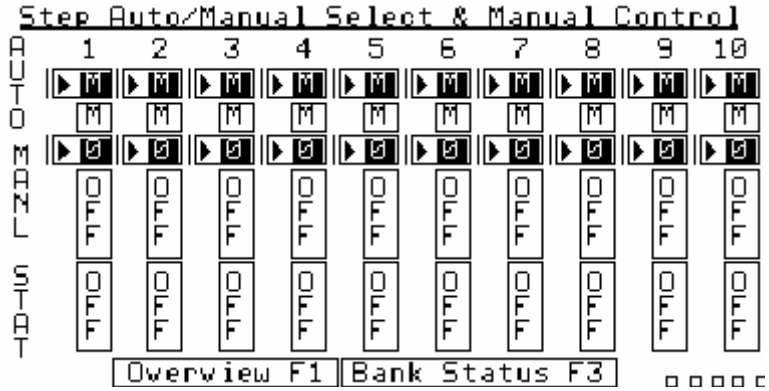
Extended Status Screen



Press the F6 function key to reset the step counters.

There are no other user-configurable fields on this screen. Press the F1 function key to return to the Overview Summary Screen.

Step Control Screen



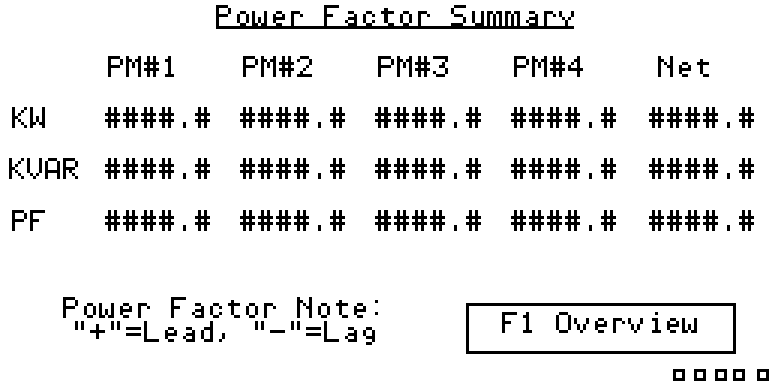
The steps are listed in vertical columns from 1…10.

The first row within the AUTO row commands whether to allow manual or automatic control of each individual step. Use the arrow keys to navigate to each individual command. The second row within the AUTO row, gives the status of each individual step. A = Automatic, M = Manual.

The first row within the MANL row commands the step to be turned on. 0 = Off, 1 = On. The step must be in Manual mode to allow for manual command of that particular step. The second row within the MANL row gives the state status of each individual step, ON or OFF.

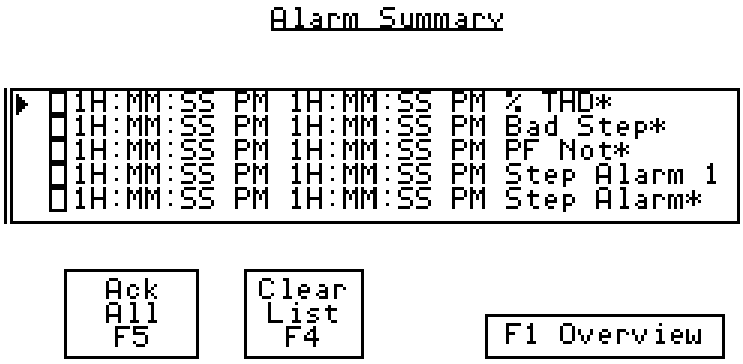
The STAT row gives the final status of each individual step.

Power Factor Summary Screen



There are no user-configurable fields on this screen. Press the F1 function key to return to the Overview Summary Screen.

Alarm Summary Screen

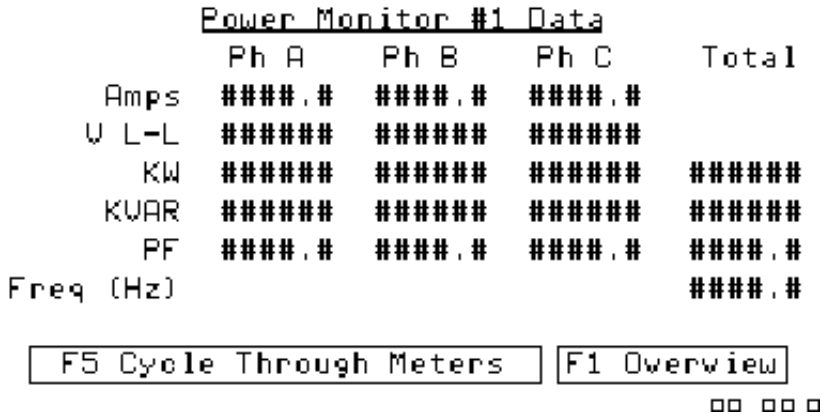

Alarm Summary
1H:MM:SS PM 1H:MM:SS PM % THD*
1H:MM:SS PM 1H:MM:SS PM Bad Step*
1H:MM:SS PM 1H:MM:SS PM PF Not*
1H:MM:SS PM 1H:MM:SS PM Step Alarm 1
1H:MM:SS PM 1H:MM:SS PM Step Alarm*
Ack All F5
Clear List F4
F1 Overview

Alarms are listed in the center of the screen. Alarms can be cleared and acknowledged by moving the curser over the appropriate field and pressing the Enter key. Use the up / down keys to change the state and the Enter key to record or save the change. Press the Backspace key to cancel the change.

Press the F1 function key to return to the Overview Summary Screen.

Powermonitor Meter Screen

There are four instances of this screen, one for each of the Powermonitor meters.



There are no user-configurable fields on this screen. Press the F5 function key to cycle to the next Powermonitor Data Screen. Press the F1 function key to return to the Overview Summary Screen.

SCADA Interface

Power-circuit Parameters

The capacitor bank controller reads power-circuit parameters from the Powermonitor meters and makes that data available in its data table for use by other applications such as SCADA or HMI systems.

The following table lists the Powermonitor meter data available in the controller. The symbol x indicates the Powermonitor meter number. Addresses related to Powermonitor meter no. 1 begin with F11:0, addresses related to Powermonitor meter no. 2 begin with F12:0.

Available Powermonitor Meter Data

Address	Parameter
F1x:0	L1 Current
F1x:1	L2 Current
F1x:2	L3 Current
F1x:3	L1-L2 Voltage
F1x:4	L2-L3 Voltage
F1x:5	L3-L1 Voltage
F1x:6	Frequency
F1x:7	L1 Real Power
F1x:8	L2 Real Power
F1x:9	L3 Real Power
F1x:10	Total Real Power
F1x:11	L1 Reactive Power
F1x:12	L2 Reactive Power
F1x:13	L3 Reactive Power
F1x:14	Total Reactive Power
F1x:15	L1 Power Factor
F1x:16	L2 Power Factor
F1x:17	L3 Power Factor
F1x:18	Total Power Factor
F1x:19	Measured Total %THD Voltage

Additional data is available in systems with the Ethernet Powermonitor meter option.

In these systems, all Powermonitor meter data may be accessed using the Ethernet communications port integral to the Powermonitor meter.

Please refer to the Powermonitor 3000 User Manual, publication 1404-UM001, for further information.

Add Special Functionality

For added functionality, custom ladder-logic programming and hardware integration are permitted, however, strict guidelines must be followed to comply with warranty contracts.

- Altering of existing ladder-logic code is prohibited and will void all warranty contracts.
- Additional functionality can only be implemented by adding additional ladder logic code to subroutine **PFMGR4**.
- Additional subroutines may be written, but must be called through **PFMGR4**.

PFMGR4 Logic

The following sections provide details of PFMGR4 ladder-logic programming.

Overview

There are three basic sections to PFMGR4:

- Power factor alarm

  The power-factor alarming section specifies whether your system KVAR is within its specified range and how long to wait before alarming when it is out of range.

- Step control

  The step control section specifies when to actuate or trip a step.

- Step routine

  The step routine section specifies what step should be actuated or tripped.

Power Factor Alarm

The ladder logic code for this section has already been written. The following is an explanation of the ladder logic code for lines one through four.

If BUS_NET_KVAR (F8:2) falls outside of the limits defined by KVAR_Lag_DB (N7:35) and PFMGR4_LEAD_DB_NEG (N94:0), then the timer PF_INRANGE__TIMER_4 (T93:0) will be started. The default time for this timer is 60 seconds. When this timer is done timing, it will latch KVAR_NOT_ACHEIVED (B56:2) and reset the timer.

If BUS_NET_KVAR (F8:2) is within the limits defined by KVAR_Lag_DB (N7:35) and PFMGR4_LEAD_DB_NEG (N94:0), then reset PF_INRANGE__TIMER_4 (T93:0) and unlatch KVAR_NOT_ACHEIVED (B56:2).

The above process sets the flag, KVAR_NOT_ACHEIVED (B56:2), which indicates when the system KVAR is out of your specified limits. This flag is used for HMI alarming.

Step Control

The step control consists of three parts. Part 1 specifies under what conditions to tell the system that a step is waiting to be actuated or tripped. Part 2 specifies under what conditions to tell the system that a step should be actuated. Part 3 specifies under what conditions to tell the system that a step should be tripped.

The following ladder logic examples are recommended formats for your custom coding.

Part 1

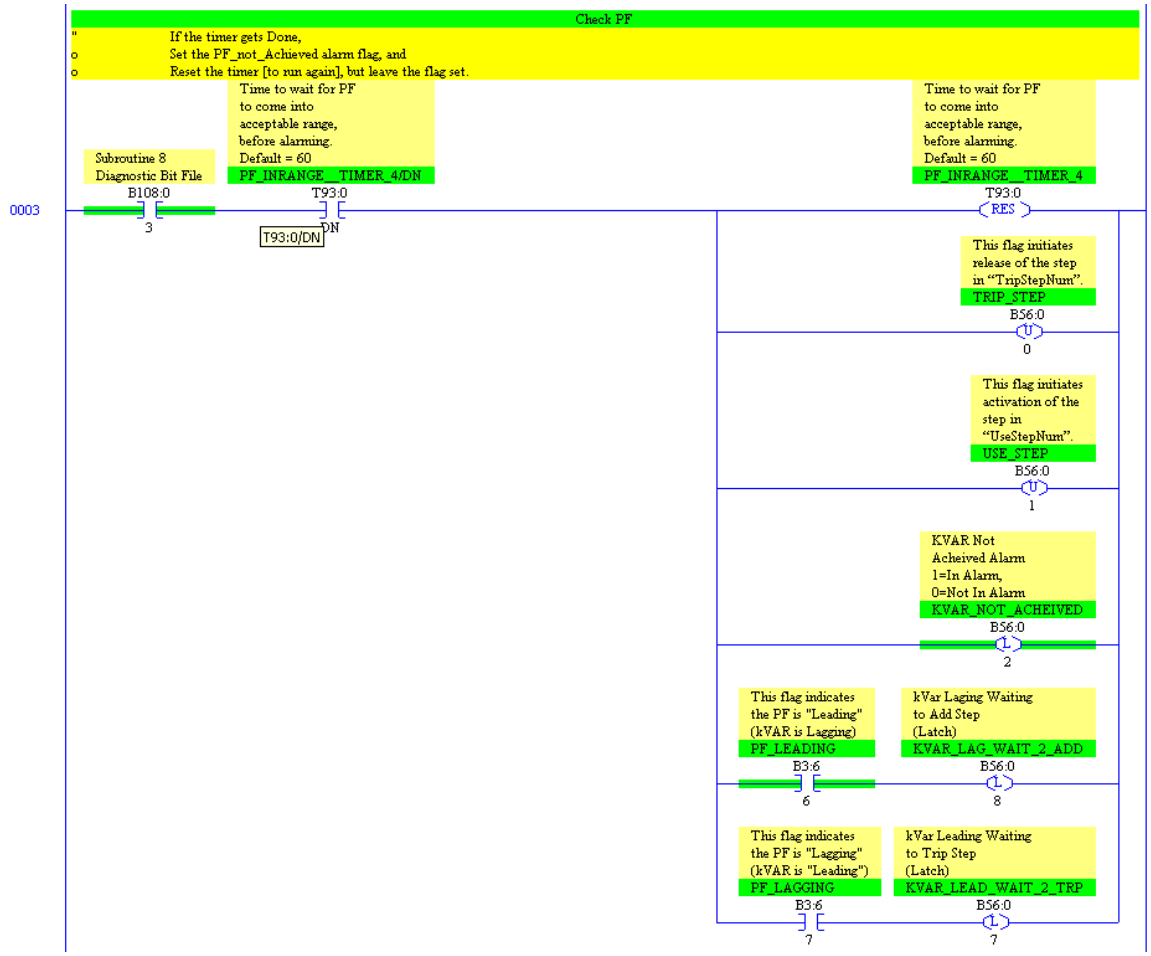
If PF_INRANGE__TIMER_4 (T93:0) is done timing

- If PF_LEADING (B3:6/6) is high, and under any user-defined conditions, latch KVAR_LAG_WAIT_2_ADD (B56:0/8).
- If PF_LAGGING (B3:6/7) is high, and under any other user-defined conditions, latch KVAR_LEAD_WAIT_2_TRIP (B56:0/7).

Part 1 should be implemented at line three in parallel with the outputs of that rung.

See Part 1 Example.

Part 1 Example

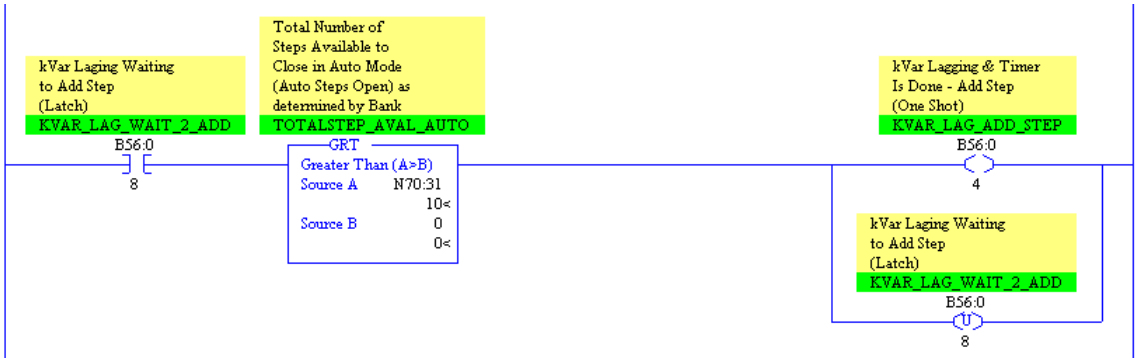


Part 2

If KVAR_LAG_WAIT_2_ADD (B56:0/8) is high and TOTALSTEP_AVAL_AUTO (N70:31) is greater than 0, then output energize KVAR_LAG_ADD_STEP (B56:0/4) and unlatch KVAR_LAG_WAIT_2_ADD (B56:0/8). This will actuate the required step defined by the step routine.

See Part 2 Example.

Part 2 Example

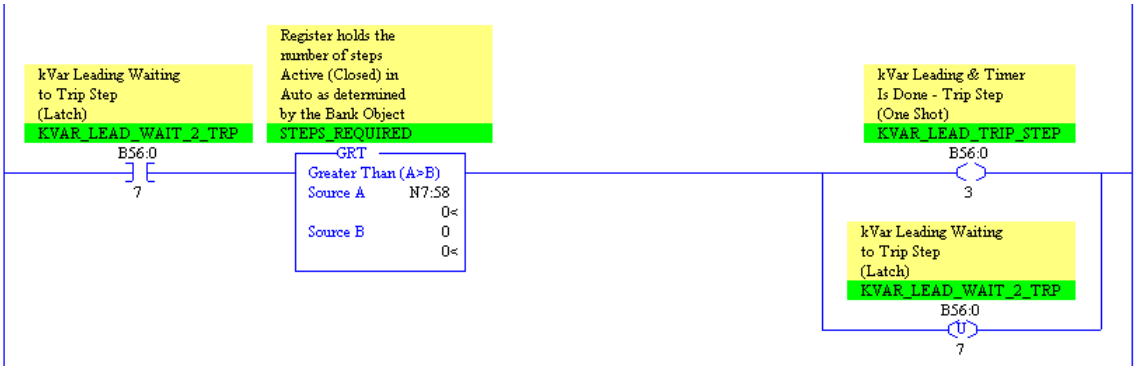


Part 3

If KVAR_LEAD_WAIT_2_TRIP (B56:0/7) is high and STEPS_REQUIRED (N7:58) is greater than 0, then Output Energize KVAR_LAG_TRIP_STEP (B56:0/3) and unlatch KVAR_LAG_WAIT_2_ADD (B56:0/7). This will trip the required step defined by the step routine.

See Part 3 Example.

Part 3 Example



Step Routine

This section defines what step to use or trip. The outputs for the Step Routine are USE_STEP_NUM (N58:1) and TRIP_STEP_NUM (N58:0). When a step is controlled to be used, the step equal to the value in USE_STEP_NUM (N58:1) will be actuated. When a step is controlled to be tripped, the step equal to the value in TRIP_STEP_NUM (N58:1) will be tripped.

User Variables

This chart displays a list of data points and their access rights for use in your custom code.

User-defined Variables

Symbol	Datapoint	Description	Datatype	Units	Access Privilege
System Status					
PF_leading	B3/.102	This flag indicates the power factor is leading.	Bit		Read
PF_lagging	B3/.103	This flag indicates the power factor is lagging.	Bit		Read
Bus_Net_PF	F8:00	This register holds the total power factor on the monitored bus.	Float		Read
Bus_Net_KW	F8:01	This register holds the total real power on the monitored bus.	Float	W	Read
Bus_Net_KVAR	F8:02	This register holds the total reactive power on the monitored bus.	Float	kVAR	Read
Bus_Volts	F8:15	This register holds the three-phase average line-to-line voltage as measured by the first Powermonitor meter.	Float	V	Read
Net_Current	F8:16	This register holds the net current obtained from the Powermonitor meter.	Float	A	Read
%THD_V	F8:17	This register holds the % total harmonic-distortion voltage as measured by the first Powermonitor meter.	Float		Read
KVAR_Lead_DB	N7:34	Leading kVAR dead-band limit, typically 33% of smallest step.	Int		Read
KVAR_Lag_DB	N7:35	Lagging kVAR dead-band limit, typically 66% of largest step.	Int		Read
PF_inRange_ Timer_4	T93:0	Time to wait for PF to come into acceptable range, before alarming.	Timer		Read
Step Status					
Open_1	B3/00	This flag indicates that Contactor #1 has been activated. (0 = Open, 1 = Active)	Bit		Read
Open_2	B3/01	This flag indicates that Contactor #2 has been activated. (0 = Open, 1 = Active)	Bit		Read
Open_3	B3/02	This flag indicates that Contactor #3 has been activated. (0 = Open, 1 = Active)	Bit		Read
Open_4	B3/03	This flag indicates that Contactor #4 has been activated. (0 = Open, 1 = Active)	Bit		Read
Open_5	B3/04	This flag indicates that Contactor #5 has been activated. (0 = Open, 1 = Active)	Bit		Read
Open_6	B3/05	This flag indicates that Contactor #6 has been activated. (0 = Open, 1 = Active)	Bit		Read
Open_7	B3/06	This flag indicates that Contactor #7 has been activated. (0 = Open, 1 = Active)	Bit		Read

User-defined Variables

Symbol	Datapoint	Description	Datatype	Units	Access Privilege
Open_8	B3/07	This flag indicates that Contactor #8 has been activated. (0 = Open, 1 = Active)	Bit		Read
Open_9	B3/08	This flag indicates that Contactor #9 has been activated. (0 = Open, 1 = Active)	Bit		Read
Open_10	B3/09	This flag indicates that Contactor #10 has been activated. (0 = Open, 1 = Active)	Bit		Read
Step_Available_1	B64/50	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_2	B64/51	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_3	B64/52	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_4	B64/53	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_5	B64/54	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_6	B64/55	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_7	B64/56	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_8	B64/57	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_9	B64/58	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Step_Available_10	B64/59	This flag indicates that the step is available to participate in automatic control. (1 = Available)	Bit		Read
Power Factor Control					
KVAR_Lead_Wait_2_Trip	B56:0/7	This flag indicates that a step is waiting to be tripped.	Bit		Read/Write
KVAR_Lag_Wait_2_Add	B56:0/8	This flag indicates that a step is waiting to be added.	Bit		Read/Write
KVAR_Lead_Trip_Step	B56:0/3	This flag commands the system to trip the selected step.	Bit		Read/Write
KVAR_Lag_Add_Step	B56:0/4	This flag commands the system to add the selected step.	Bit		Read/Write
Trip_Step_Num	N58:0	This register holds the number of the step to release.	Int		Read/Write
Use_Step_Num	N58:1	This register holds the number of the step to activate.	Int		Read/Write
PM1 Data					
PM_1_I1	F11:0	PM #1, L1 Current		A	Read
PM_1_I2	F11:1	PM #1, L2 Current		A	Read
PM_1_I3	F11:2	PM #1, L3 Current		A	Read
PM_1_L12	F11:3	PM #1, L1-L2 Voltage		V	Read

User-defined Variables

Symbol	Datapoint	Description	Datatype	Units	Access Privilege
PM_1_L23	F11:4	PM #1, L2-L3 Voltage		V	Read
PM_1_L31	F11:5	PM #1, L3-L1 Voltage		V	Read
PM_1_Freq	F11:6	PM #1, Frequency		Hz	Read
PM_1_P1	F11:7	PM #1, L1 Real Power		W	Read
PM_1_P2	F11:8	PM #1, L2 Real Power		W	Read
PM_1_P3	F11:9	PM #1, L3 Real Power		W	Read
PM_1_PT	F11:10	PM #1, Total Real Power		W	Read
PM_1_Q1	F11:11	PM #1, L1 Reactive Power		VAR	Read
PM_1_Q2	F11:12	PM #1, L2 Reactive Power		VAR	Read
PM_1_Q3	F11:13	PM #1, L3 Reactive Power		VAR	Read
PM_1_QT	F11:14	PM #1, Total Reactive Power		VAR	Read
PM_1_PF1	F11:15	PM #1, L1 Power Factor			Read
PM_1_PF2	F11:16	PM #1, L2 Power Factor			Read
PM_1_PF3	F11:17	PM #1, L3 Power Factor			Read
PM_1_PFT	F11:18	PM #1, Total Power Factor			Read
PM_1_%THD	F11:19	PM #1, measured Total Harmonic Distortion percentage		%	Read
PM2 Data					
PM_2_I1	F12:0	PM #2, L1 Current		A	Read
PM_2_I2	F12:1	PM #2, L2 Current		A	Read
PM_2_I3	F12:2	PM #2, L3 Current		A	Read
PM_2_L12	F12:3	PM #2, L1-L2 Voltage		V	Read
PM_2_L23	F12:4	PM #2, L2-L3 Voltage		V	Read
PM_2_L31	F12:5	PM #2, L3-L1 Voltage		V	Read
PM_2_Freq	F12:6	PM #2, Frequency		Hz	Read
PM_2_P1	F12:7	PM #2, L1 Real Power		W	Read
PM_2_P2	F12:8	PM #2, L2 Real Power		W	Read
PM_2_P3	F12:9	PM #2, L3 Real Power		W	Read
PM_2_PT	F12:10	PM #2, Total Real Power		W	Read
PM_2_Q1	F12:11	PM #2, L1 Reactive Power		VAR	Read
PM_2_Q2	F12:12	PM #2, L2 Reactive Power		VAR	Read
PM_2_Q3	F12:13	PM #2, L3 Reactive Power		VAR	Read
PM_2_QT	F12:14	PM #2, Total Reactive Power		VAR	Read
PM_2_PF1	F12:15	PM #2, L1 Power Factor			Read
PM_2_PF2	F12:16	PM #2, L2 Power Factor			Read
PM_2_PF3	F12:17	PM #2, L3 Power Factor			Read

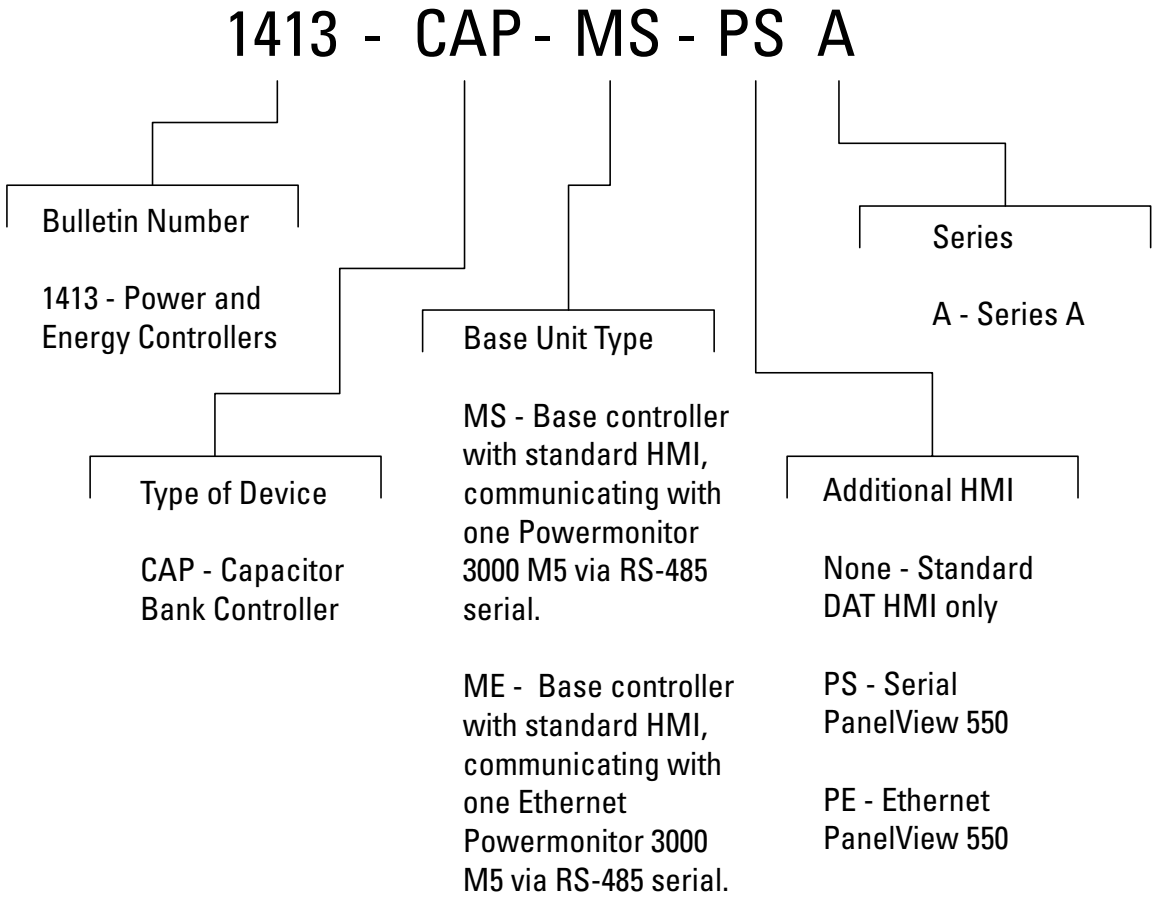
User-defined Variables

Symbol	Datapoint	Description	Datatype	Units	Access Privilege
PM_2_PFT	F12:18	PM #2, Total Power Factor			Read
PM_2_%THD	F12:19	PM #2, measured Total Harmonic Distortion percentage		%	Read
PM3 Data					
PM_3_I1	F13:0	PM #3, L1 Current		A	Read
PM_3_I2	F13:1	PM #3, L2 Current		A	Read
PM_3_I3	F13:2	PM #3, L3 Current		A	Read
PM_3_L12	F13:3	PM #3, L1-L2 Voltage		V	Read
PM_3_L23	F13:4	PM #3, L2-L3 Voltage		V	Read
PM_3_L31	F13:5	PM #3, L3-L1 Voltage		V	Read
PM_3_Freq	F13:6	PM #3, Frequency		Hz	Read
PM_3_P1	F13:7	PM #3, L1 Real Power		W	Read
PM_3_P2	F13:8	PM #3, L2 Real Power		W	Read
PM_3_P3	F13:9	PM #3, L3 Real Power		W	Read
PM_3_PT	F13:10	PM #3, Total Real Power		W	Read
PM_3_Q1	F13:11	PM #3, L1 Reactive Power		VAR	Read
PM_3_Q2	F13:12	PM #3, L2 Reactive Power		VAR	Read
PM_3_Q3	F13:13	PM #3, L3 Reactive Power		VAR	Read
PM_3_QT	F13:14	PM #3, Total Reactive Power		VAR	Read
PM_3_PF1	F13:15	PM #3, L1 Power Factor			Read
PM_3_PF2	F13:16	PM #3, L2 Power Factor			Read
PM_3_PF3	F13:17	PM #3, L3 Power Factor			Read
PM_3_PFT	F13:18	PM #3, Total Power Factor			Read
PM_3_%THD	F13:19	PM #3, measured Total Harmonic Distortion percentage		%	Read
PM4 Data					
PM_4_I1	F14:0	PM #4, L1 Current		A	Read
PM_4_I2	F14:1	PM #4, L2 Current		A	Read
PM_4_I3	F14:2	PM #4, L3 Current		A	Read
PM_4_L12	F14:3	PM #4, L1-L2 Voltage		V	Read
PM_4_L23	F14:4	PM #4, L2-L3 Voltage		V	Read
PM_4_L31	F14:5	PM #4, L3-L1 Voltage		V	Read
PM_4_Freq	F14:6	PM #4, Frequency		Hz	Read
PM_4_P1	F14:7	PM #4, L1 Real Power		W	Read
PM_4_P2	F14:8	PM #4, L2 Real Power		W	Read
PM_4_P3	F14:9	PM #4, L3 Real Power		W	Read
PM_4_PT	F14:10	PM #4, Total Real Power		W	Read

User-defined Variables

Symbol	Datapoint	Description	Datatype	Units	Access Privilege
PM_4_Q1	F14:11	PM #4, L1 Reactive Power		VAR	Read
PM_4_Q2	F14:12	PM #4, L2 Reactive Power		VAR	Read
PM_4_Q3	F14:13	PM #4, L3 Reactive Power		VAR	Read
PM_4_QT	F14:14	PM #4, Total Reactive Power		VAR	Read
PM_4_PF1	F14:15	PM #4, L1 Power Factor			Read
PM_4_PF2	F14:16	PM #4, L2 Power Factor			Read
PM_4_PF3	F14:17	PM #4, L3 Power Factor			Read
PM_4_PFT	F14:18	PM #4, Total Power Factor			Read
PM_4_%THD	F14:19	PM #4, measured Total Harmonic Distortion percentage		%	Read

Catalog Number Explanation


1413 - CAP - MS - PS A
Bulletin Number
1413 - Power and Energy Controllers
Type of Device
CAP - Capacitor Bank Controller
Base Unit Type
MS - Base controller with standard HMI, communicating with one Powermonitor 3000 M5 via RS-485 serial.
ME - Base controller with standard HMI, communicating with one Ethernet Powermonitor 3000 M5 via RS-485 serial.
Additional HMI
None - Standard DAT HMI only
PS - Serial PanelView 550
PE - Ethernet PanelView 550
Series
A - Series A

Base Unit

The base unit can have serial meter communications or Ethernet meter communications.

With Serial Powermonitor 1413-CAP-MS A

Includes base controller and one Powermonitor PM3000-M5 meter on RS-485. Note that MS = serial meter communications. Communications between the MicroLogix controller and the Powermonitor meter are RS-485 serial.

With Ethernet Powermonitor 1413-CAP-ME A

Includes base controller and one Powermonitor PM3000-M5 meter on the Ethernet network. Note that ME = Ethernet meter communications. Communications between the MicroLogix controller and the Powermonitor meter are RS-485 serial.

Additional HMI

To add a serial PanelView 550 HMI to the system, add PS or PE to the catalog number. A PS indicates HMI with serial communications. A PE indicates HMI with Ethernet communications. When PS or PE is omitted, only the DAT is supplied.

Serial Base Unit with Serial HMI 1413-CAP-MS-PS A

Uses the standard HMI on the front of the MicroLogix controller and includes a small, serial PanelView 550 HMI in addition.

Serial Base Unit with Ethernet HMI 1413-CAP-MS-PE A

Uses the standard HMI on the front of the MicroLogix controller and includes a small, Ethernet PanelView 550 HMI in addition.

Ethernet Base Unit with Ethernet HMI 1413-CAP-ME-PE A

Uses the standard HMI on the front of the MicroLogix controller and includes a small, Ethernet PanelView 550 HMI in addition. This option includes Ethernet communications from HMI to both the MicroLogix controller and the Powermonitor PM-3000 M5 meter. The controller still uses RS-485 to gather control data from the PM directly.

Summary

Catalog Number	Powermonitor Meters	PanelView Terminals	MicroLogix Controller to PM Communications	MicroLogix Controller to PanelView Terminal Communications	MicroLogix Controller to SCADA Communications
1413-CAP-ME A	Enet	None	Serial	None	Serial
1413-CAP-ME-PE A	Enet	Enet	Serial	Enet	Enet
1413-CAP-ME-PS A	Enet	Serial	Serial	Serial	None
1413-CAP-MS A	Serial	None	Serial	None	Serial
1413-CAP-MS-PS A	Serial	Serial	Serial	Serial	None

Bank

An overall capacitor or tuned-filter assembly. This controller is designed to manage and control one bank consisting of 10 steps.

Instance

An instance of an object represents a complete iteration of an object and all of its attributes and methods. For example, the vacuum switch describes a typical vacuum switch. Each physical switch would result in one instance of a vacuum switch object. Each instance of an object must be managed independently in the software.

PM

See Powermonitor meter.

Powermonitor meter

The power measuring device located at the plant mains. There may be more than one Powermonitor meter in a system depending on the number of electrical feeds into the plant.

Step

A single switched circuit in a capacitor or filter bank. There are up to ten steps in a bank. Others in the industry may also refer to these as stages.

A

AIC+ 14
alarm summary screen 47
alarms 39
assemble controller 11
  MicroLogix 1500 11

B

bank status screen 44

C

catalog number explanation 61
communications configuration 20
  additional Powermonitors option 22
  base unit 20
  Ethernet HMI option 21
  serial HMI option 21
configuration 20
connect controller 11
  AIC+ 14
  MicroLogix 1500 11
  PanelView 550 Ethernet 18
  PanelView 550 serial 16
  Powermonitor 14
controller configuration 26
  PanelView 550 HMI 42
  use DAT 31
  with PanelView 550 33

D

description 5

E

extended status screen 45

G

general information 5

I

installation 7

M

mount controller 11
  AIC+ 14
  MicroLogix 1500 11
  PanelView 550 Ethernet 18
  PanelView 550 serial 16
  Powermonitor 14

N

navigation menu screen 44

O

operating modes 37
operation 37
operator interface 39
  DAT 40
overview summary screen 44

P

PanelView 550 Ethernet 18
PanelView 550 Serial 16
PFMGR4 logic 51
  overview 51
  power factor alarming 52
  step control 52
  user variables 55
power factor summary screen 46
Powermonitor 14
  configuration 23
  parameter descriptions 24
  screen 48
  set parameters with display module 24

S

SCADA interface 49
screen navigation tree 43
special functionality 51
step control screen 46
system architecture 9
  ethernet options 10
  serial options 9
system components 7

U

use DAT 31
use display module 24

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For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect Support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://support.rockwellautomation.com.

Installation Assistance

If you experience a problem with a hardware module within the first 24 hours of installation, please review the information that's contained in this manual. You can also contact a special Customer Support number for initial help in getting your module up and running.

United States	1.440.646.3223 Monday – Friday, 8am – 5pm EST
Outside United States	Please contact your local Rockwell Automation representative for any technical support issues.

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Publication 1413-UM001C-EN-P - May 2006 PN 40055-228-01(3)
Supersedes Publication 1413-UM001B-EN-P - January 2006
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